

# **Earth Observing System Geoscience Laser Altimeter System**

## **GLAS I-SIPS Software Detailed Design Document**

Version 1.0  
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## GLAS I-SIPS DETAILED DESIGN DOCUMENT

### 3 Introduction

The GLAS I-SIPS Software consists of three parts. The main part is the Science Processing system that creates multiple data products and consists of an Executor that runs a set of four subsystems: L1A, Waveform, Atmosphere, and Elevation. The Data Preparation and Handling subsystem supports the Science Processing system by acquiring the raw data and user information, and performing scheduling, staging, archiving and distribution of the data products. A set of Utilities complements the I-SIPS software by formatting data products, creating intermediate ancillary products and facilitating Quality Control.

The system design allows all output products to be produced simultaneously (in parallel) or sequentially and implements these schemes by running science algorithms in the appropriate sequences. The schemes are expected to overcome the problem of excessive I/O operations involved when intermediate data files are produced in the processing stream, and to minimize the worst effects of single points of failure.

The I-SIPS software interfaces with the GLAS Science Team, the DAAC and EDOS, and the I-SIPS Team.

(Insert new Architecture diagram or description here. Also top level design and Controller diagram.)

The software design is based on a structured methodology using concepts from Yourdon, DeMarco and Harel and the analysis of the system is achieved with various constructed views that are illustrated in the following models:

- a) The Process Model – a set of Data Flow Diagrams
- b) The Dynamic Model – a set of State Transition Diagrams
- c) The Structure Model – a set of Structure Charts that identify the significant modules of the system.

### 4 Reference Documents

Science Software Management Plan

GLAS Science Data Management Plan, October 1997, NASA Goddard Space Flight Center, Wallops Flight Facility

WinA&D for Windows95/98/NT, Mac A&D, Excel Software

The Practical Guide to Structured Systems Design, 1988, Meilir Page-Jones.

Modern Structured Analysis, Yourdon

### 5 System Overview

The Data Preparation and Handling system is the front end of the system and utilizes an ORACLE database to provide the control information that determines which processes will run in the processing system. The Software is designed to implement end-to-end processing and to produce a complete set of output products. It will also perform archiving, ingesting and distribution, partial processing to create a subset of the output products and Reprocessing to create selected products.

The I-SIPS processing system is designed to be both efficient and flexible. The system was designed for operational flexibility considering data availability constraints and reprocessing requirements. In order to meet these requirements, the design of the I-SIPS processing system is based on three software layers of increasing intelligence. The bottom layer is composed of the implementations of scientific algorithms, the middle layer is composed of multiple managers responsible for the execution of the scientific algorithms, and the top layer is a main program which is responsible for data input and the execution of each manager.

The core of the I-SIPS design is a consolidation of necessary scientific algorithms. These algorithms are published in Algorithm Theroretical Basis Documents (ATBD) provided by the GLAS Science Team. The provided algorithms are grouped into ATBD subsystems separated by scientific discipline. The four subsystems are: L1A, Waveforms, Atmosphere, and Elevation. Additionally, the subsystems are designed such that data required by each subsystem is available from a product (data file) written by a preceding subsystem. The result of is no (or very little) data dependence between the subsystems.

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Associated with the ATBD subsystem are corresponding Subsystem Managers. The Subsystem Managers control which sub-ATBD algorithms to execute and what data products get written. Very little intelligence is built into the Subsystem Managers except for the order in which sub-ATBD algorithms are called and what is required to write each data product.

Finally, surrounding the four managers is a main program that is basically a state machine. This program uses control input (either file or interactive) to determine what data to read, what processes to execute, and what data to write.

During the design phase, both single-program and multiple-program approaches were considered. Advantages of the single program approach include a potentially reduced I/O burden (dependent on the operational use of the software), less software maintainence, and ease of configuration management. The disadvantages of this approach are slightly more code complexity and a potential for increased memory usage due to non-active global memory being used. The advantages of multiple programs are simplicity and relatively reduced memory usage. The disadvantages are an increased software maintenance burden and increased configuration managrement difficulty.

By keeping the top-level code very generic and developing on the single-program approach, the Team retains maximum development flexibility. If there is a solid reason not to implement the I-SIPS data processing system as a single program, it will be very easy to subset GLAS\_Exec and create four independent programs. This will allow the Team to take advantage of new information as development progresses into prototyping and load testing with a minimum of wasted effort.

The team recognizes that there will be other task-specific software which will interface with data created by the I-SIPS data processing system. In order to effect the reuse of this software, the GLAS Team will implement major components and subsystems as shared libraries. These libraries (especially the I/O library) will be as generic as possible so they may be used without modification by both internal and external programmers.

## 6 Design Issues

### 6.1 Reprocessing:

A number of reprocessing scenarios have been identified.(See Appendix D). The design allows for all possible scenarios which will originate from user inputs to the Oracle Database.

### 6.2 Time synchronizing of data

GLA00 data time/record synchronization between APIDs is currently TBD. (Develop this further)

For GLA01 and higher-level products, a *RecIndex* field will be used for record synchronization. This field will be present in each GLA file record and will contain a number that will identify each  $\approx 1/\text{sec}$  GLAS science measurement. The current definition is as follows:

YYDDDDSSSSSS

where

YY= two digit year

DDD= day of year

SSSSSS= unique second of day

In the case of missing data, the number will be incremented to account for the number of records expected.

### 6.3 Data Buffering

Data will be accessed on a per second basis. However, subsystem requirements vary and processing may proceed only when 40 such records have been accessed. This will require buffering of the data both on input and output. The main program GLAS\_Exec will perform this function and the design will incorporate this requirement.

### 6.4 Design Constraints / Decisions / Assumptions

- There will be a 1-1 temporal correspondence between L1A and L2 GLA\_SCF files. This means that the v0 software will not use multiple files of the same File Type for processing or reprocessing. This capability, however, will be built into the control structures for future use and some of this functionality is already present in the V0 release.

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- 1) All input data will be time aligned with no missing data or error data.
- 2) Imported ANC files will not be available.
  - The GLA\_ANC\_06 file will not be created using the Toolkit.
  - GLA\_SCF files will be raw data only. No header or metadata is required.

Data will be passed to the waveform processing manager one one-second record at a time.

## 6.4.1 *Issues to be Resolved before v0 Delivery*

Time Handling conventions must be finalized with respect to synchronizing GLA00 APIDs and synchronizing GLA00 data to GLA\_SCF data. Additionally, some type of initial error checking must be defined in order to assure time synchronization is not corrupted by bad data (this may or may not be a v0 requirement since v0 will work only with test data).

## 7 File Naming Conventions

(paraphrased from Hancock email, 3/4/99)

GLAS GLA files will be named as follows:

**GLAxx\_ccc\_ttt\_s**

where    xx = Product ID  
          ccc = Cycle (000-999)  
          ttt = Track (0000-2600)  
          s = Segment, (0=none, 1-4 correspond to 50° lat/lon breaks)

GLAS ANC files will be named as follows:

**ANCxx\_TBD**

where    xx = Product ID  
          TBD = To Be Determined

These conventions fulfill the requirement that the type of product is carried in the filename. It also contains temporal and geographic information which allows for a gross-level data selection.

## 8 Granule Size

(table from Hancock email, 03/04/99)

Ignoring GLA00, GLA01 is the minimum sized granule; other granules are multiples of GLA01. Corresponding output files will be opened when a new GLA01 is read. Granules never break except on a GLA01 transition.

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**Table 1. Granule Size**

Prod ID	Rec Size (bytes)	Mbytes / Day	Rate / sec	Num Recs	granules			Notes
					/rev	/day	size	
GLA01 - land	4020	1129	1 / 1	7	4	56	30	land 46.6%;
- ocean	4020	552	1 / 1	3				ocean 53.4%
GLA02	28652	2475.5	1 / 1	1	0.5	7	354	
GLA03	1000	86.4	1 / 1	1	0.07	1	86	estimate
GLA04	28000	2419.2	1 / 1	1	0.14	2	1210	estimate
GLA05	9636	832.6	1 / 1	1	4	56	15	
GLA06	5236	452.4	1 / 1	1	0.07	1	452	
GLA07	63836	5515.4	1 / 1	1	0.5	7	788	
GLA08	780	3.4	1 / 20	1	0.07	1	3	
GLA09	2948	63.7	1 / 4	1	0.07	1	64	
GLA10	13812	298.3	1 / 4	1	0.07	1	298	
GLA11	568	12.3	1 / 4	1	0.07	1	12	
GLA12	3004	29.1	1 / 1	1	0.07	1	29	Antarctic surface only
GLA13	4076	17.6	1 / 1	1	0.07	1	18	Guesstimate
GLA14	5416	165.7	1 / 1	1	0.07	1	166	Includes all surface except ocean or antarctic
GLA15	2888	133.2	1 / 1	1	0.07	1	133	

## 9 POD Replacement

(from Hancock/Jester/Jlee meeting)

The presence of a POD ANC file is sufficient indication to perform POD replacement on output products.(Anita's comments ??)

## 10 Process Model (Data Flow Diagrams)

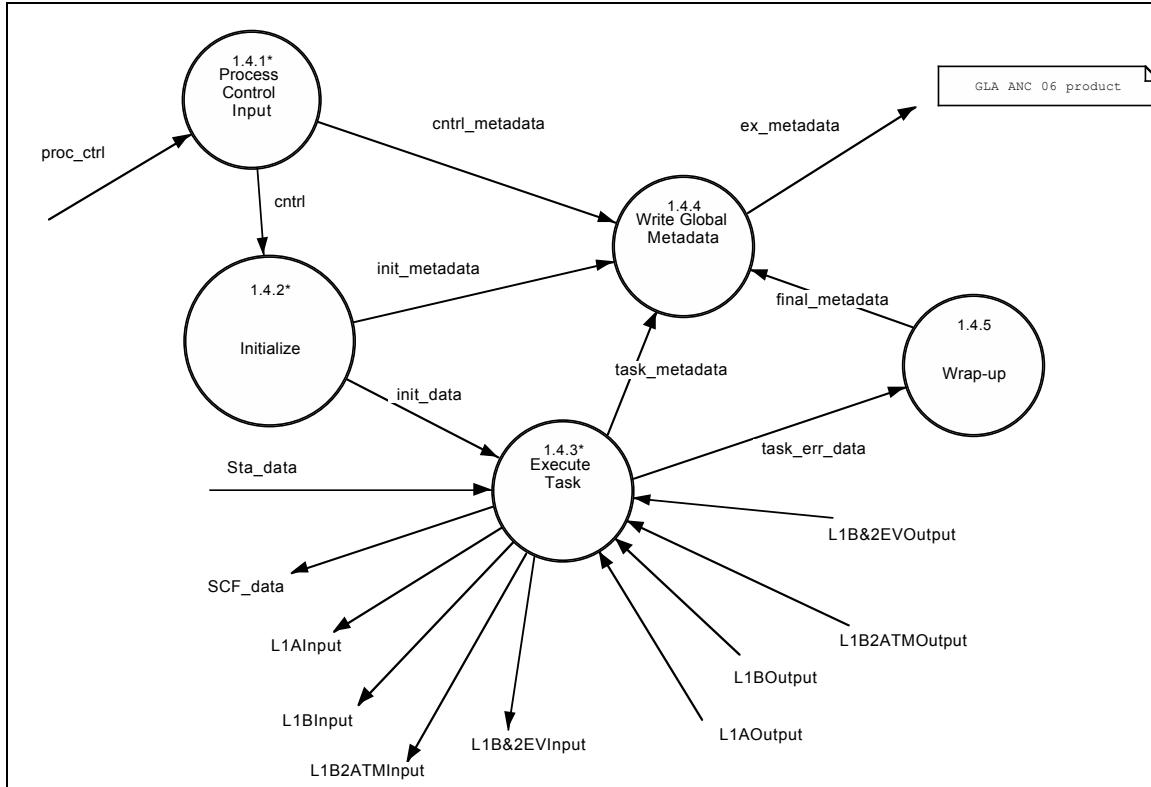
### 10.1 The I-SIPS Controller

#### 10.1.1 GLAS Exec

The topmost level of the I-SIPS data processing software is GLAS\_Exec. GLAS\_Exec is a Fortran 90 program which is spawned by the scheduler to process data. The types of data and the methods by which to process these data are determined by an associated Control File. The Control File is created from recipes defined in the database recipe table for predefined scenarios. Custom control files may also be created in order to process special-case data.

The core data processing routines of the I-SIPS processing software are categorized into four major subsystems: L1A, Waveforms, Atmosphere, and Elevation. These subsystems contain implementations of the algorithms used to process ICESAT data. GLAS\_Exec is the superstructure surrounding the four subsystems. It is responsible for control, initialization, data input, data output, and global error handling,

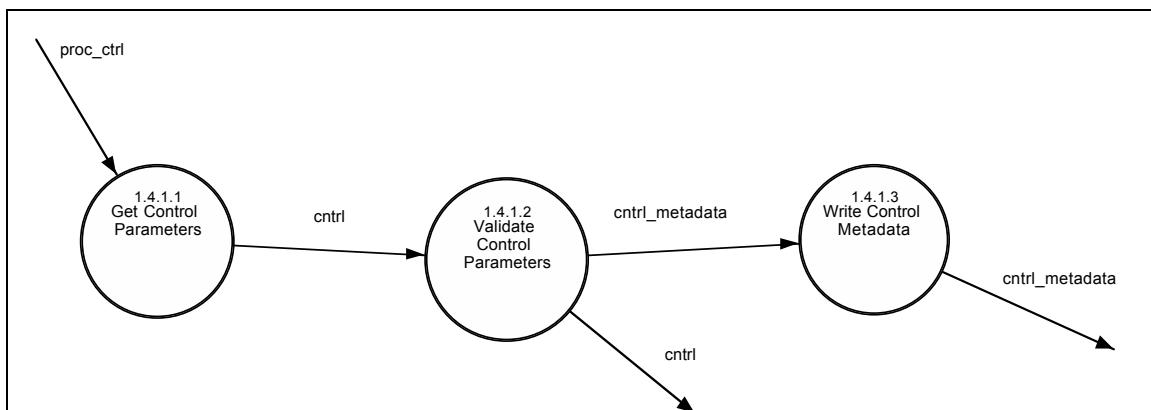
# DRAFT



**Figure 1.**

### 10.1.2 Process Control Input

Due to reprocessing requirements, GLAS\_Exec is mostly one big state machine. The control file may specify which of the GLA00 or GLA\_SCF files to use as input, what processes to execute upon the input data, and what files are to be written as output. All file naming is performed in the Data Preparation stage and the names of all input, output, and ancillary files are identified in the control file. A description of the control file and its format will be provided in (Another section? Another document?) All parsed control input, as well as things such as program name and version are written as metadata to GLA ANC 06.

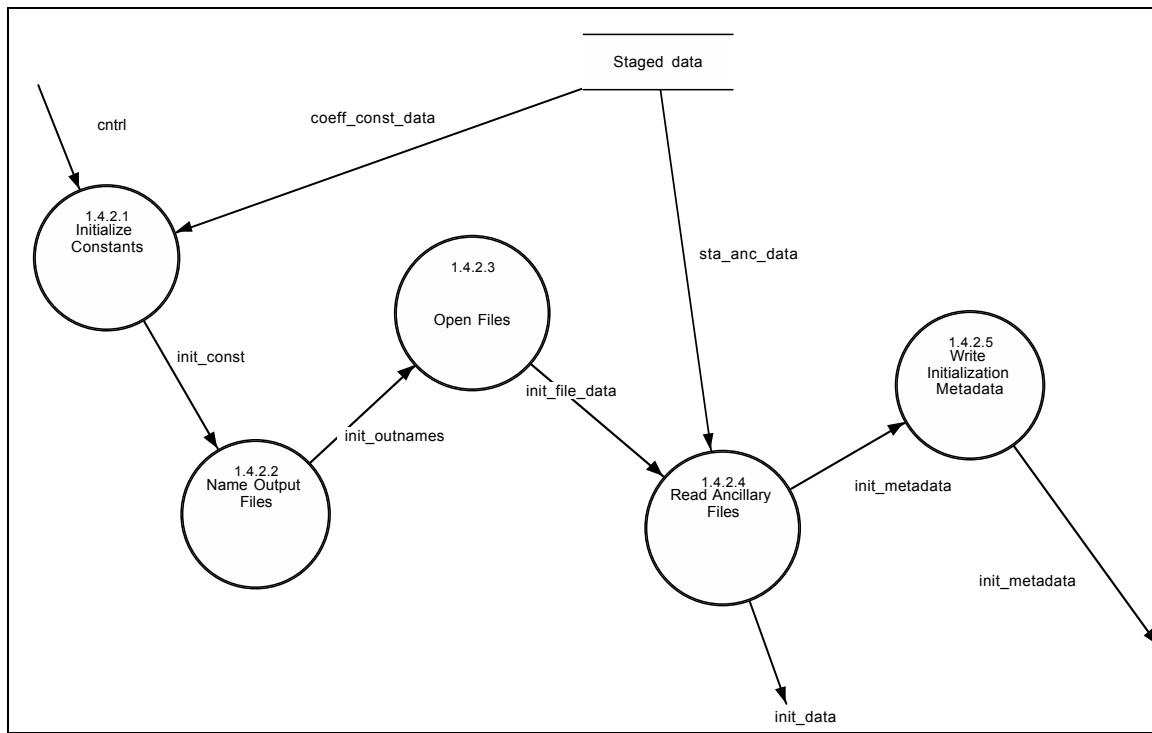


**Figure 2.**

# DRAFT

## 10.1.3 Initialize

The initialization subroutines initialize necessary constants, open the specified input, output, and ancillary files, and read the required ancillary files. Only those ancillary files whose data are determined to be efficiently kept in core are read in at this time. Note, however, that all requested ancillary files are opened here. While subsystems may independently read ancillary data files, they are not to open and close files themselves. All initialization and parsed control data are written as metadata to GLA ANC06.



**Figure 3.**

## 10.1.4 Execute Task

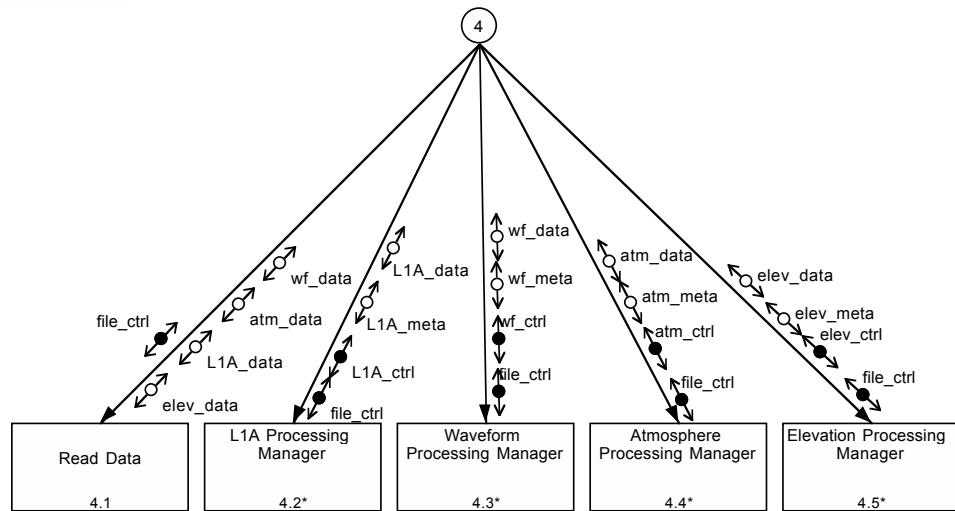
### 10.1.4.1 Read Data

After Initialization, data are read and processed in a main processing loop until all input products reach end-of-file. Control Flags will signify what data to read and what Managers to execute. Availability flags will signify when a particular type of data is available.

Data are read from file, converted into scientific units, and stored into appropriate shared-memory data structures. Most data are read on a record-by-record (1sec) basis. However, because of multiple-record requirements in the Atmosphere Subsystem, 20 seconds of GLAxx, GLAxx, and GLAxxx data will be buffered when processing the Atmosphere xxx sub-ATBD. Execution of the Elevation processes will not be deferred, but output must be

# DRAFT

(Loop Record-by-Record Till EOF)



**Figure 4.**

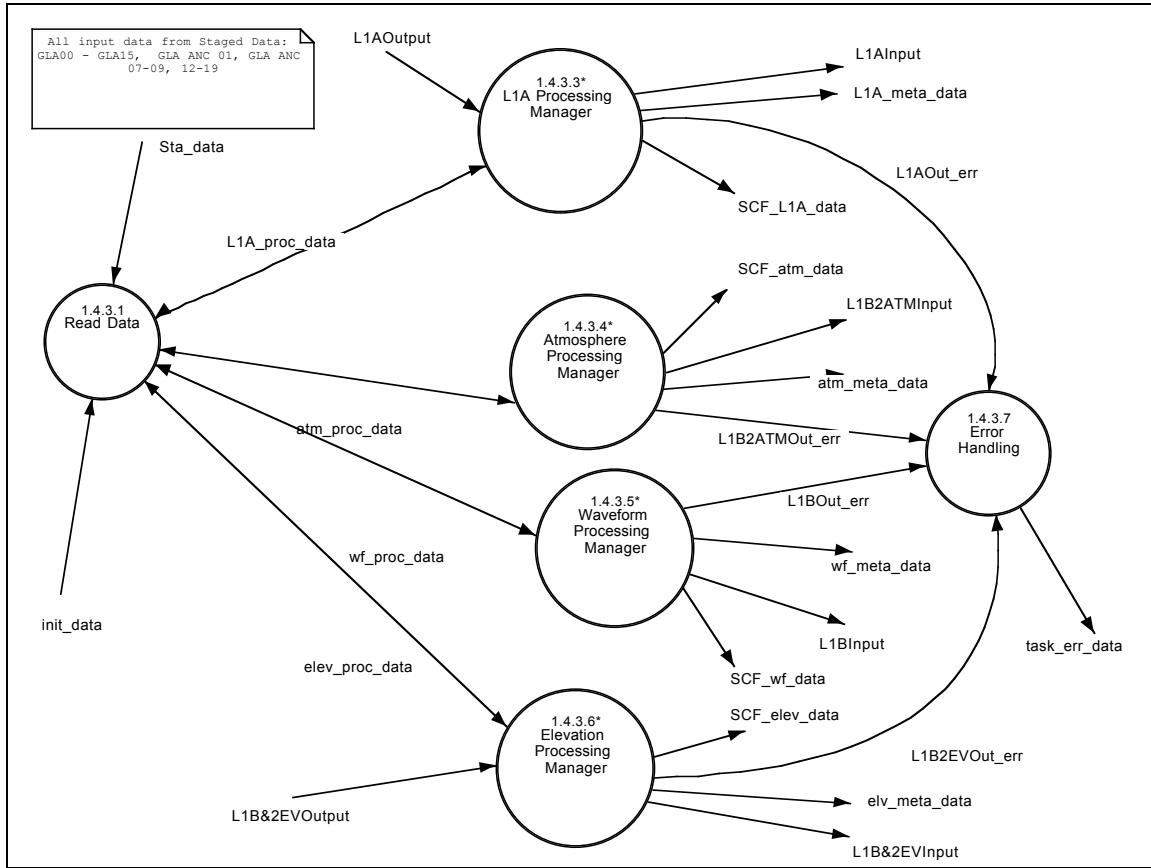
buffered because of the cloud indicator flag needed on GLAxx and GLAxx which is created by the Atmosphere subsystem using a 20 second average. This issue will be addressed further at a later date.

#### 10.1.4.2 Subsystem Managers

Subsystem Managers control the top-most level of each subsystem. These managers are responsible for the execution of specified sub-ATBDs, the creation of appropriate GLA\_SCF data products, and any post-record wrap-up. The managers are also responsible for the transfer of non-computed data (i.e., pass-through data) from one SCF product to another.

The way the pass-thru transfer process works is a subtle, yet important one. Pass-thru parameters are moved to the appropriate subsequent product to facilitate the abstraction of processing and reprocessing code. In other words, during the flow of the Subsystem Manager, parameters are moved from a sequentially lower numbered product to a higher numbered product prior to the sub-ATBD which creates data for the higher numbered product being called. Pass-thru data which is placed on the higher numbered product is used in the call in the sub-ATBD rather than from the lower-numbered source product. This allows the sub-ATBD to be coded such that it does not matter if it is being run in a processing or re-processing scenario.

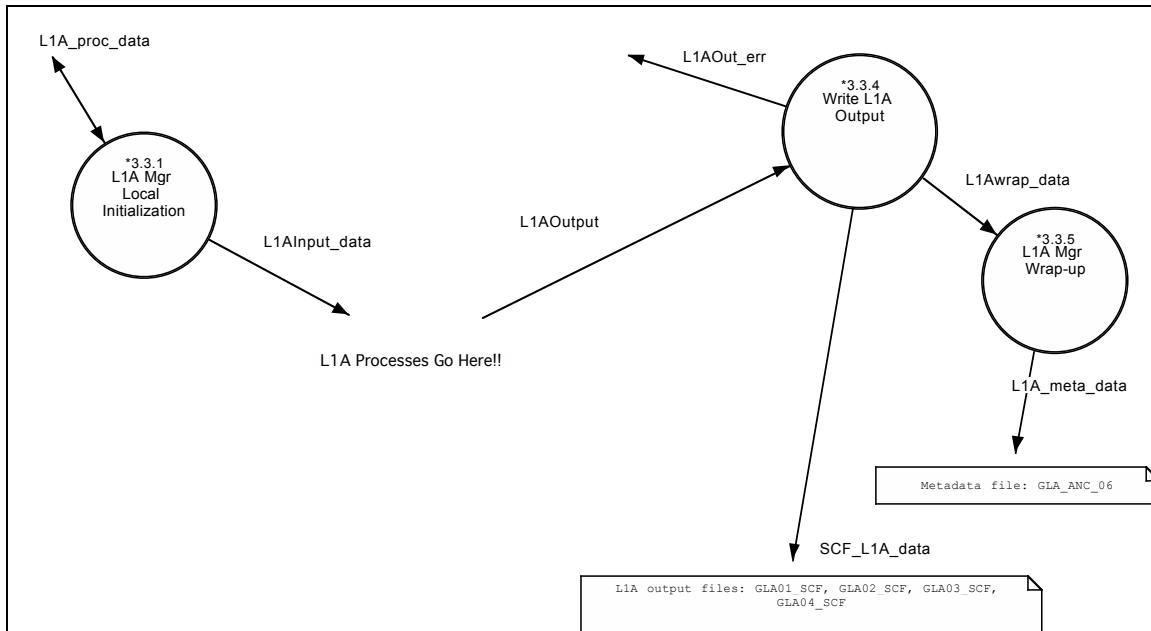
# DRAFT



**Figure 5.**

### 10.1.4.2.1 L1A Manager

This is the L1A Processing Manager. Controllable DFDs from the L1A subsystem will be merged into this diagram.

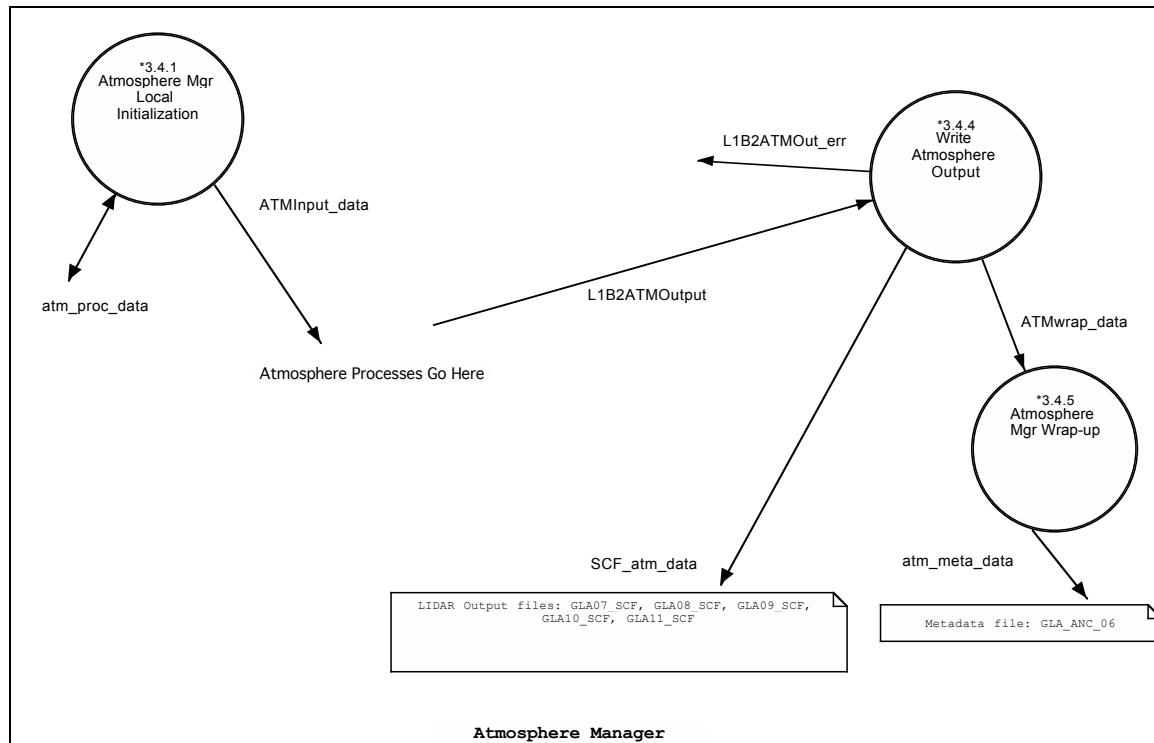


**Figure 6.**

# DRAFT

## 10.1.4.3 Atmosphere Manager

This is the Atmosphere Processing Manager. Controllable DFDs from the Atmosphere subsystem will be merged into this diagram.

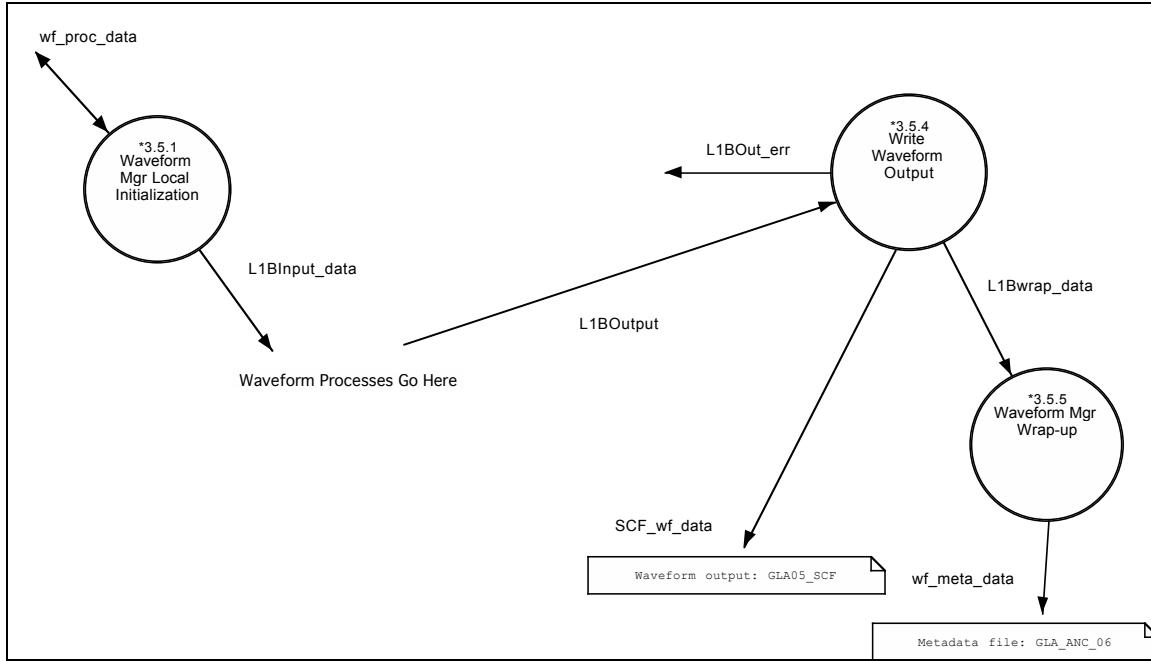


**Figure 7.**

## 10.1.4.4 Waveforms Manager

This is the Waveforms Processing Manager. Controllable DFDs from the Waveforms subsystem will be merged into this diagram.

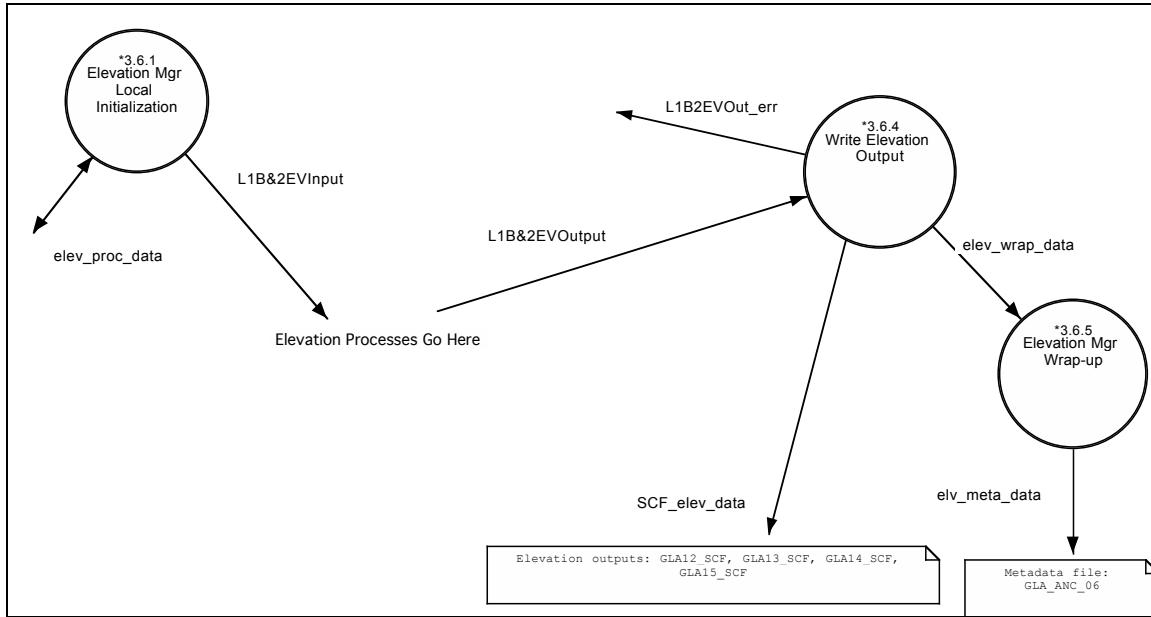
# DRAFT



**Figure 8.**

#### 10.1.4.5 Elevation Manager

This is the Elevation Processing Manager. Controllable DFDs from the Elevation subsystem will be merged into this diagram.



**Figure 9.**

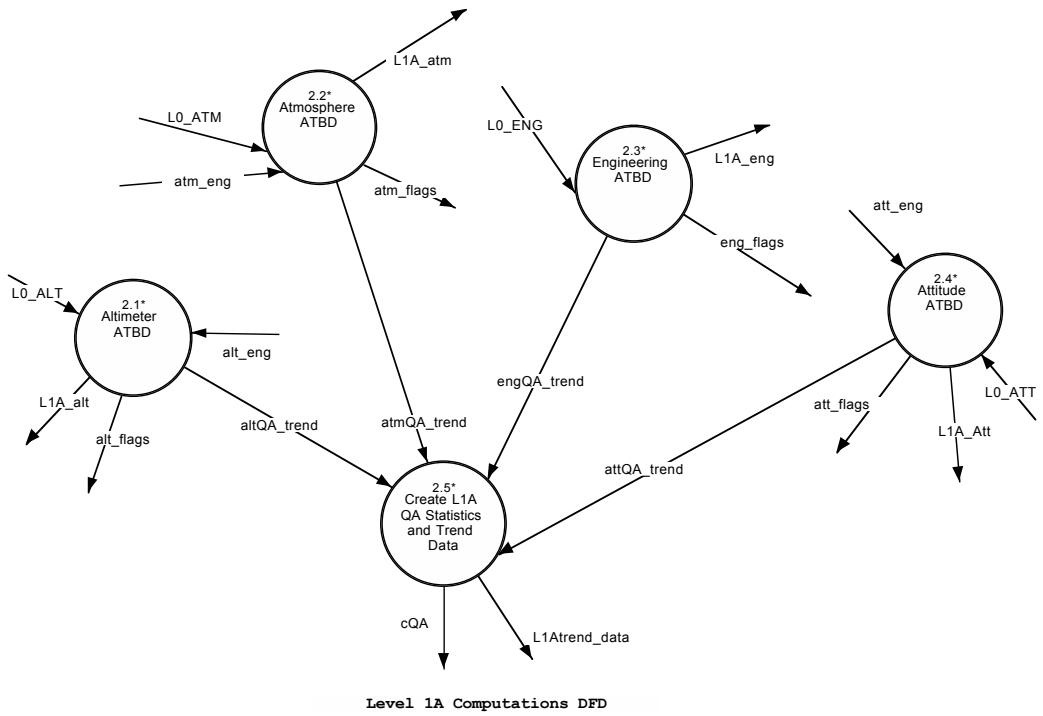
#### 10.1.5 Data Preparation, Formatting, Archiving

This section is being developed for insertion here.

# DRAFT

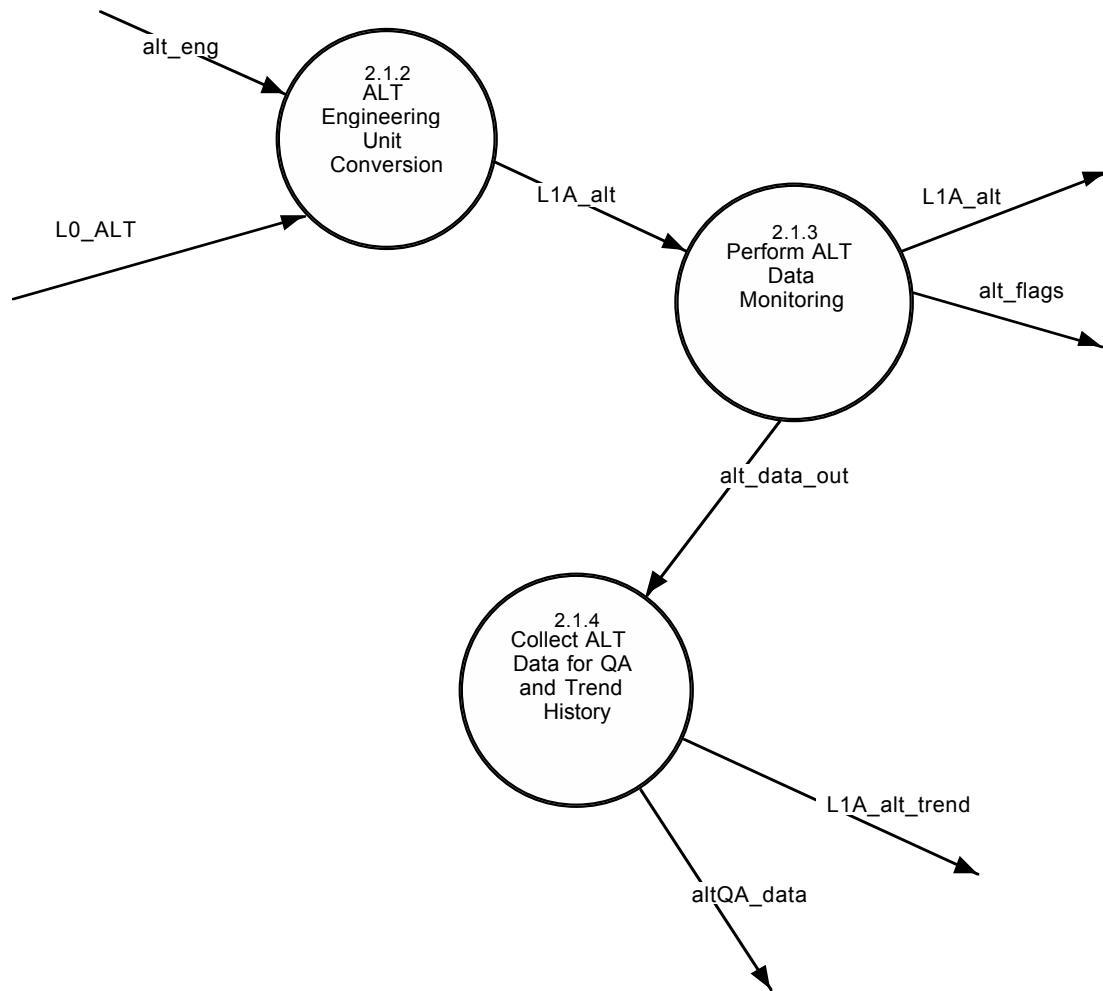
## 10.2 Level 1A Computations

### I. DFDs and their Descriptions



**Figure 10.**

## 10.3 Altimeter ATBD (*L\_Alt*)



**Figure 11.**

To generate the data for the Level 1A Altimeter Data product (L1A\_alt). This process converts the Level 0 altimetry data (L0\_ALT) to engineering units; checks for data out of limits; collects data for QA statistics and trend history (altQA\_trend).

#### *10.3.1 ALT Engineering Unit Conversion (L\_alteuc)*

This subprocess performs engineering unit conversion on the raw Level 0 altimetry data (L0\_alt\_data) to obtain the Level 1A altimetry data.

#### *10.3.2 Perform ALT Data Monitoring (L\_altmon)*

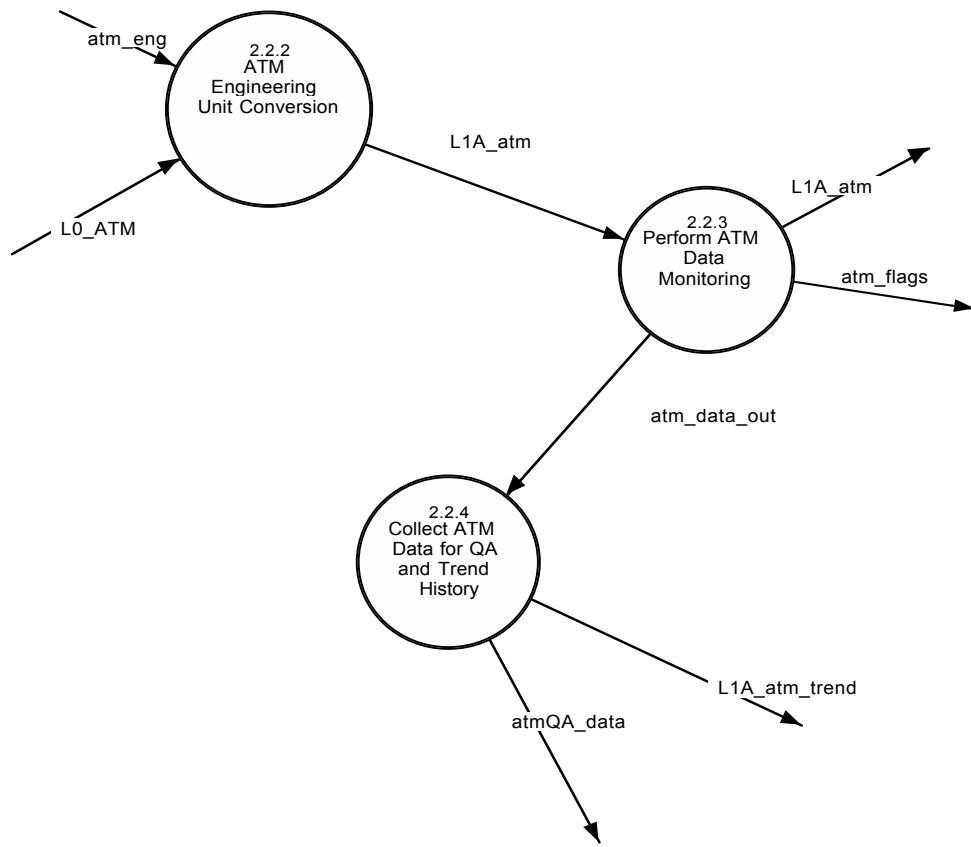
This subprocess compares the Level 1A altimetry data (L1A\_alt) to preset monitoring limits and thresholds. This subprocess may compare current values to previous value to determine any short term instrument trends. Data required for QA and trend history (atm\_data\_out) are output to subprocess 2.1.3. Flags are set appropriately to indicate monitoring results (alt\_data\_out).

#### *10.3.3 Collect ALT Data for QA and Trend History (L\_altqatrnd)*

This subprocess takes the data generated during the EUC and monitoring subprocesses and generates QA and trend data. Any Level 1A data required to aid in this process is input as part of alt\_data\_out.

# DRAFT

## 10.4 Atmosphere ATBD (*L\_At*)



**Figure 12.**

To generate the data for the Level 1A Atmosphere Data product (L1A\_atm). This process converts the Level 0 data to engineering units; checks for the data out of limits; collects data for QA statistics and trend history (atm\_QA\_trend).

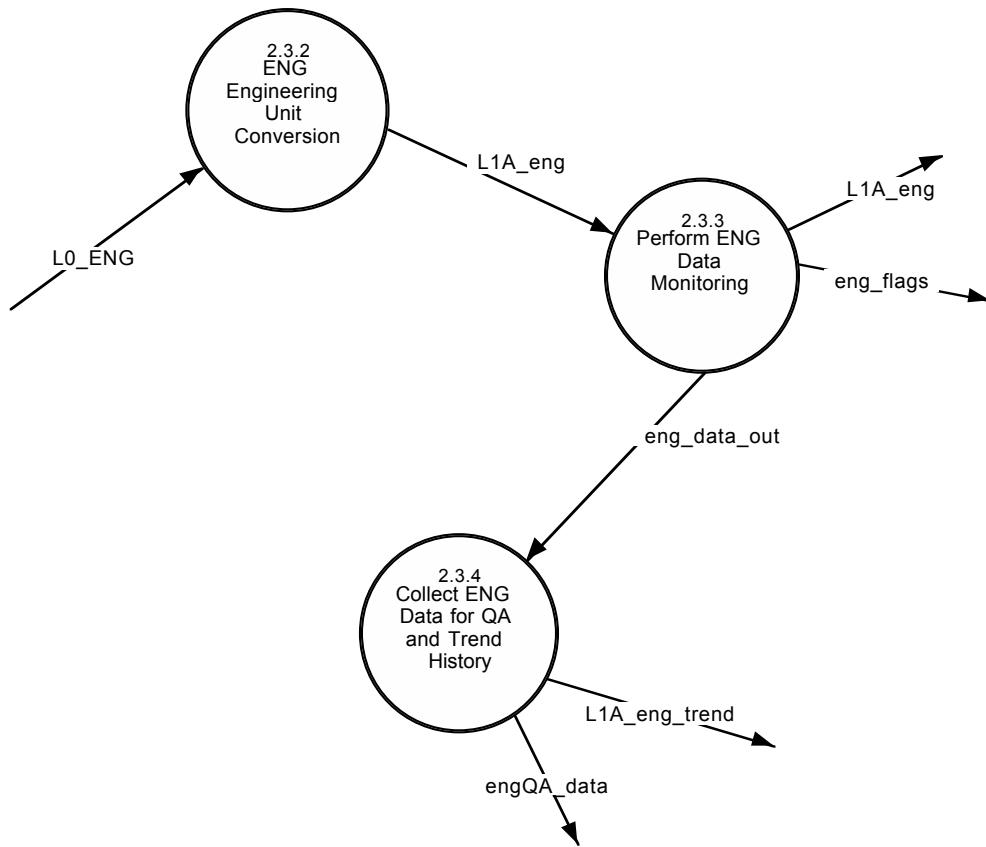
### 10.4.1 ATM Engineering Unit Conversion (*L\_atmeuc*)

This subprocess performs engineering unit conversion on the raw Level 0 atmosphere data to obtain the Level 1A atmosphere data.

### 10.4.2 Perform ATM Data Monitoring (*L\_atmmon*)

This subprocess compares the Level 1A atmosphere data (L1A\_atm) to preset monitoring limits and thresholds. This subprocess may compare current values to previous value to determine any short term instrument trends. Data required for QA and trend history (atm\_data\_out) are output to subprocess 2.2.3. Flags are set appropriately to indicate monitoring results (atm\_data\_out).

# DRAFT



**Figure 13.**

#### 10.4.3 Collect ATM Data for QA and Trend History (*L\_atmqatrnd*)

This subprocess takes the data generated during the EUC and monitoring subprocesses and generates QA (atmQA\_data) and trend data (L1A\_atm\_trend). Any Level 1A data required to aid in this process is input as part of atm\_data\_out.

### 10.5 Engineering ATBD (*L\_Eng*)

To generate the data for the Level 1A Engineering Data product (L1A\_eng). This process determines the state of the instrument from the Level 0 data; converts the Level 0 engineering data to engineering units; checks for the data out of limits; collects data for QA statistics and trend history (engQA\_trend).

#### 10.5.1 ENG Engineering Unit Conversion (*L\_engeuc*)

This subprocess performs engineering unit conversion on the raw Level 0 engineering data (L0\_eng\_data) to obtain the Level 1A engineering data (L1A\_eng). The state of the instrument is determined during this subprocess.

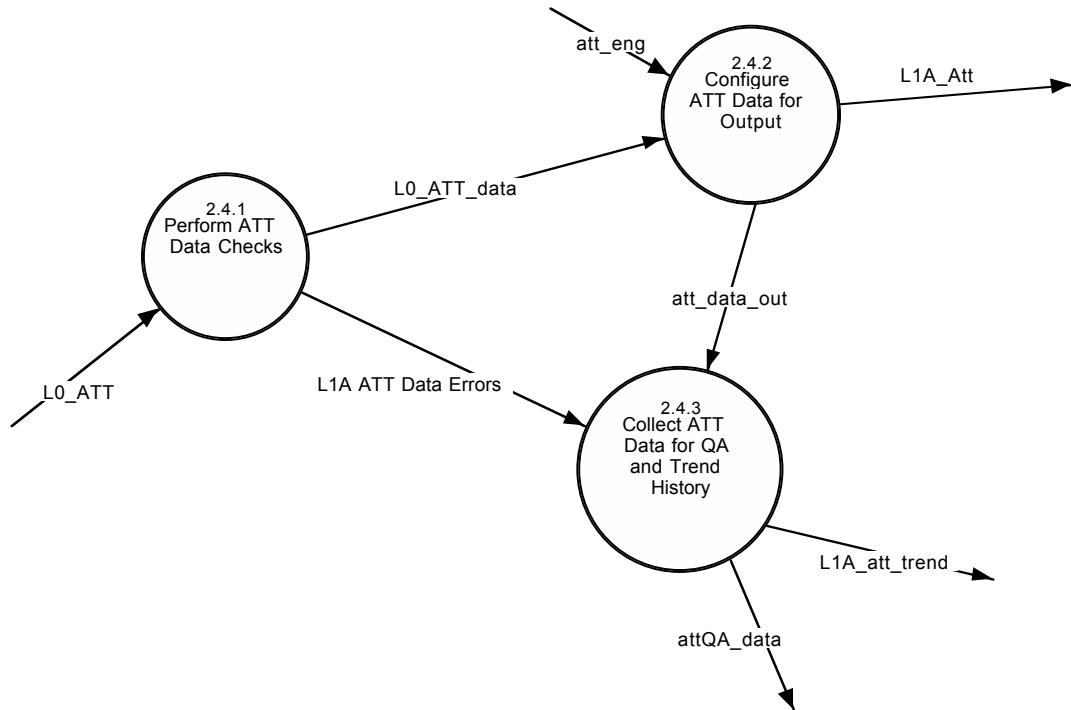
#### 10.5.2 Perform ENG Data Monitoring (*L\_engmon*)

This subprocess compares the Level 1A engineering data (L1A\_eng) to preset monitoring limits and thresholds. This subprocess in particular evaluates the temperatures, currents, etc. to determine that the instrument is in good health. This subprocess may compare current values to previous value to determine any short term instrument trends. Data required for QA and trend history (eng\_data\_out) are output to subprocess 2.3.3. Flags are set appropriately to indicate monitoring results (eng\_data\_out).

# DRAFT

### 10.5.3 Collect ENG Data for QA and Trend History (*L\_engqatrnd*)

This subprocess takes the data generated during the EUC and monitoring subprocesses and generates QA (*engQA\_data*) and trend (*L1A\_eng\_trend*) data. Any Level 1A data required to aid in this process is input as part of *eng\_data\_out*.



**Figure 14.**

## 10.6 Attitude ATBD (*L\_Att*)

This process writes the Level 0 data required for the precision orbit and attitude determination algorithms to the Level 1A Attitude Data Product (*L1A\_att*). The Level 0 packets are checked for errors, the data is configured for output and any QA and trend data is collected.

### 10.6.1 Perform ATT Data Checks (*L\_attachkdata*)

The Level 0 Attitude packets (*L0\_ATT*) are checked for completeness and for valid data. Any errors (*L1A ATT Data Errors*) are sent to subprocess 2.4.4 for handling. During this subprocess any necessary flags are set indicating the state of the instrument. The Level 0 attitude data including the instrument state and any additional information (*L0\_ATT\_data*) is sent to subprocess 2.4.2.

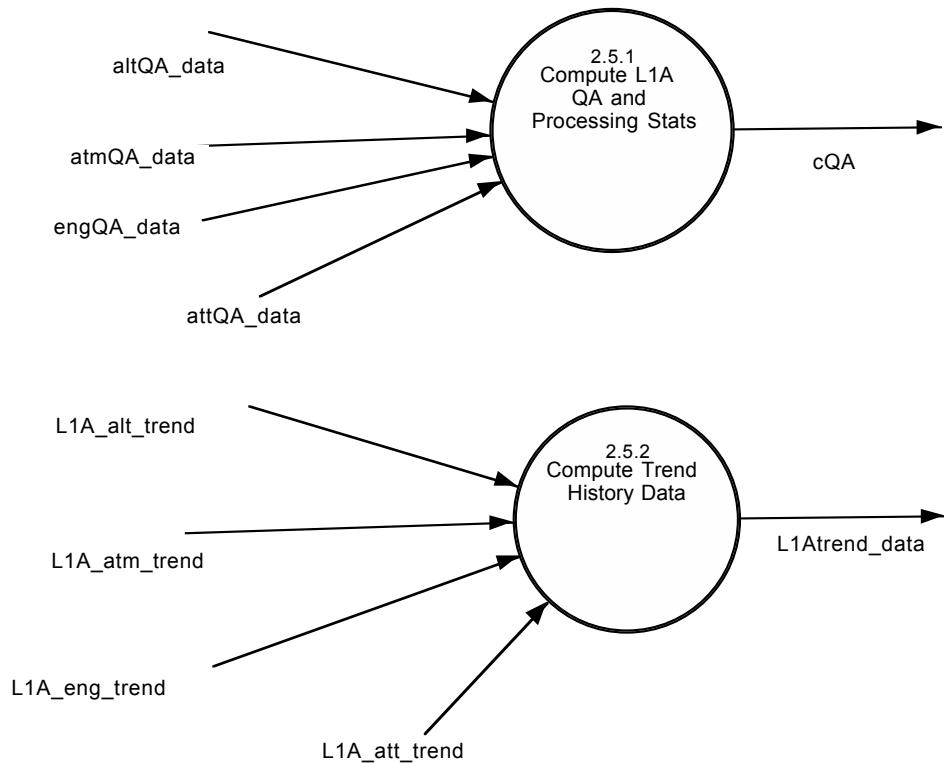
### 10.6.2 Configure Data for Output (*L\_attconfig*)

Any reformatting of the data required for the Level 1A Attitude Product file is performed in this subprocess (*L1A\_att*). Data required for QA and trend history (*att\_data\_out*) are output to subprocess 2.4.3.

### 10.6.3 Collect ATT Data for QA and Trend History (*L\_attqatrnd*)

This subprocess takes the data generated during the packet checks or data configuring subprocesses and generates QA (*attQA\_data*) and trend (*L1A\_att\_trend*) data. Any Level 1A data required to aid in this process is input as part of *att\_data\_out*.

# DRAFT



**Figure 15.**

## 10.7 Create L1A QA Statistics and Trend Data (*L\_QA\_Trnd*)

This process computes the QA statistics from the data collected by the Level 1A ATBD processes. This process also computes Level 1A trend data describing the performance of the instrument.

### 10.7.1 Compute L1A QA and Processing Stats (*L\_compsstat*)

This subprocess uses the QA data (altQA, atmQA, engQA, attQA) generated by the subprocesses and any additional L1A data to generate the cumulative QA statistics (cQA) describing the Level 1A data products and their generation.

### 10.7.2 Compute Trend History Data (*L\_comptrnd*)

This subprocess uses the trend data (L1A\_att\_trend, L1A\_atm\_trend, L1A\_eng\_trend, L1A\_att\_trend) generated by the subprocesses and any additional L1A data to generate the trend data (L1Atrend\_data) describing the Level 1A data products and the performance and health of the instrument.

## 10.8 Level 1B Waveforms

### 10.8.1 Function

The Level 1B Waveforms subsystem computes the geolocation, and produces waveform-based information required to produce the elevation products (GLA05\_SCF).

### 10.8.2 Design Constraints / Decisions / Assumptions

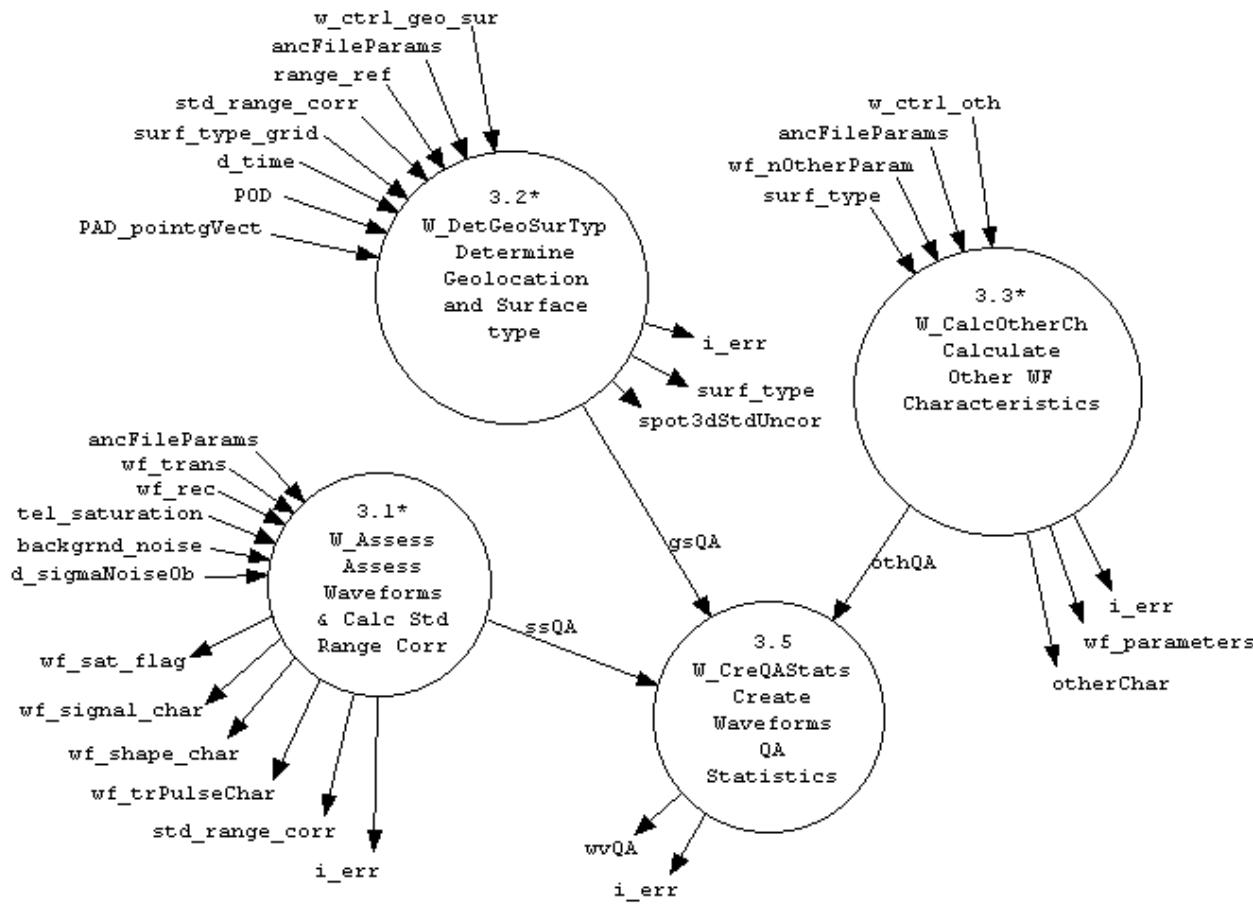
Data will be passed to the waveform processing manager one one-second record at a time.  
Each record will have 40 waveforms.

# DRAFT

The time between waveforms is assumed to be 1/40 sec.

The parameters listed in table 4-1 of the GLAS ATBD will be passed to the waveform processes as a module (ancFileParams - see data flow diagrams).

All data will be passed to the lowest level possible as arrays in order to take advantage of Fortran 90's matrix arithmetic.



**Figure 16.**

The Level 1B Waveforms subsystem is divided into four processes (W\_Assess, W\_DetGeoSurTyp, W\_CalcOtherCh, & W\_CreQASstats) which generate waveform-based information required to produce the elevation products (GLA05\_SCF). Processes W\_DetGeoSurTyp and W\_CalcOtherCh are triggered by control flags (w\_ctrl\_geo\_sur and w\_ctrl\_oth) which indicate original processing or a reprocessing scenario. In addition to producing waveform-based information, processes W\_Assess, W\_DetGeoSurTyp and W\_CalcOtherCh generate QA data (ssQA, gsQA, and othQA) which is passed to process W\_CreQASstats, where QA statistics are created for the subsystem (wvQA) for inclusion in the summary information product (GLA ANC 06). Following is a description of each of the processes:

## 10.9 Assess Waveforms & Calc Std Range Corr (W\_Assess)

Utilizes the transmitted waveforms (wf\_trans), received waveforms (wf\_rec), telemetered saturation (tel\_saturation - Psattm in the ATBD), background noise (backgrnd\_noise), and the standard deviation of the background noise level calculated by the on board algorithm (d\_sigmaNoiseOb - σnoise\_ob in ATBD) to perform a general assessment of the waveforms including: a check for waveform saturation (wf\_sat\_flag); defining the begin and end of noise & signal (wf\_signal\_char); characterizing the transmitted pulse (wf\_trPulse\_char); and calculating various shape characteristics (wf\_shape\_char), and then to calculate the standard range correction (std\_range\_corr).

# DRAFT

wf\_sat\_flag indicates whether waveform signal saturation is minimal (normal waveform processing is applied), moderate (some information on elevation can be approximated) or excessive (no waveform processing is applied).

wf\_signal\_char includes a flag indicating if no signal was found in the waveform (l\_flag\_signal), the time of the beginning of the waveform signal (d\_sig\_beg), time of the end of the waveform signal (d\_sig\_end), time of the beginning of a selected region within the waveform signal (d\_time\_beg), time of the end of a selected region within the waveform signal (d\_time\_end), noise (d\_noise, either calculated by the instrument or calculated from the waveform), and the standard deviation of noise (d\_sigmaNs).

wf\_shape\_char includes the maximum amplitude of the waveform (d\_max), the centroid of waveform from time\_beg to time\_end (d\_centroid), the area of the waveform from time\_beg to time\_end (d\_area), the skewness (d\_skewness), and the kurtosis (d\_kurtosis).

wf\_trPulseChar includes the location of the peak (d\_peak\_loc), the standard deviation of the pulse (d\_sigma), the peak amplitude (d\_amp), the centroid of the pulse (d\_centroid), and the skewness of the pulse (d\_skewness).

## 10.10 Determine Geolocation and Surface Type (W\_DetGeoSurTyp)

Utilizes precision orbit data (POD\_FileInfo gives information needed to read the orbit data), precision attitude data pointing vector (PAD\_pointgVect), standard range correction (std\_range\_corr), reference range (ref\_range), type of surface grid (surf\_type\_grid), and the time (d\_time) to determine the geographic location (spot3dStdUncor - standard uncorrected latitude, longitude and elevation) and the type of surface (surf\_type).

surf\_type includes flags indicating the surface type(s) of the nodes from the surface-type grid (surf\_type\_grid) that surround the spot location.

## 10.11 Calculate Other WF Characteristics (W\_CalcOtherCh)

Utilizes the waveform and other waveform parameters (wf\_nOtherParam), and the type of surface (surf\_type - the algorithms for land and other-than-land surfaces are different) to fit the waveform to a function and return the calculated waveform function parameters (wf\_parameters), and other characteristics (otherChar).

wf\_nOtherParam includes the received waveforms (wf\_rec), time (d\_time), the background noise level measured by the instrument (d\_noise), and the standard deviation of background noise level calculated by the on board algorithm (d\_sigmaNs).

wf\_parameters includes two of each of the following parameters (one set from the land algorithm and the other from the non-land algorithm): the number of gaussians used to model the waveform (i\_NgausL & i\_NgausO); the amplitude of the gaussian (d\_ampL & d\_ampO); the standard deviation of the gaussian (d\_sigmaL & d\_sigmaO); the position of the gaussian (d\_posL & d\_posO); and the noise level from the gaussian fit (d\_noisel & d\_noiseO).

otherChar includes the number of peaks found in the raw waveform (i\_NpeakInit), the number of peaks in the smoothed waveform (i\_NpeakSoln); the rank of the peaks in the solution (i\_peakRanks); the standard deviation of the waveform to the final fitting function; the centroid of the smoothed waveform from time\_beg to time\_end (d\_centroidSm); a flag indicating if the fit was unsuccessful - ie. if the normal matrix turns singular (l\_flagFitNoGo); and a flag indicating if the fit ended without meeting the convergence criteria (l\_flagFitMaxIter).

## 10.12 Create Waveforms QA Statistics (W\_CreQAStats)

Combines QA data from the previous four processes (ssQA, gsQA, and othQA) to create QA statistics for the subsystem (wvQA).

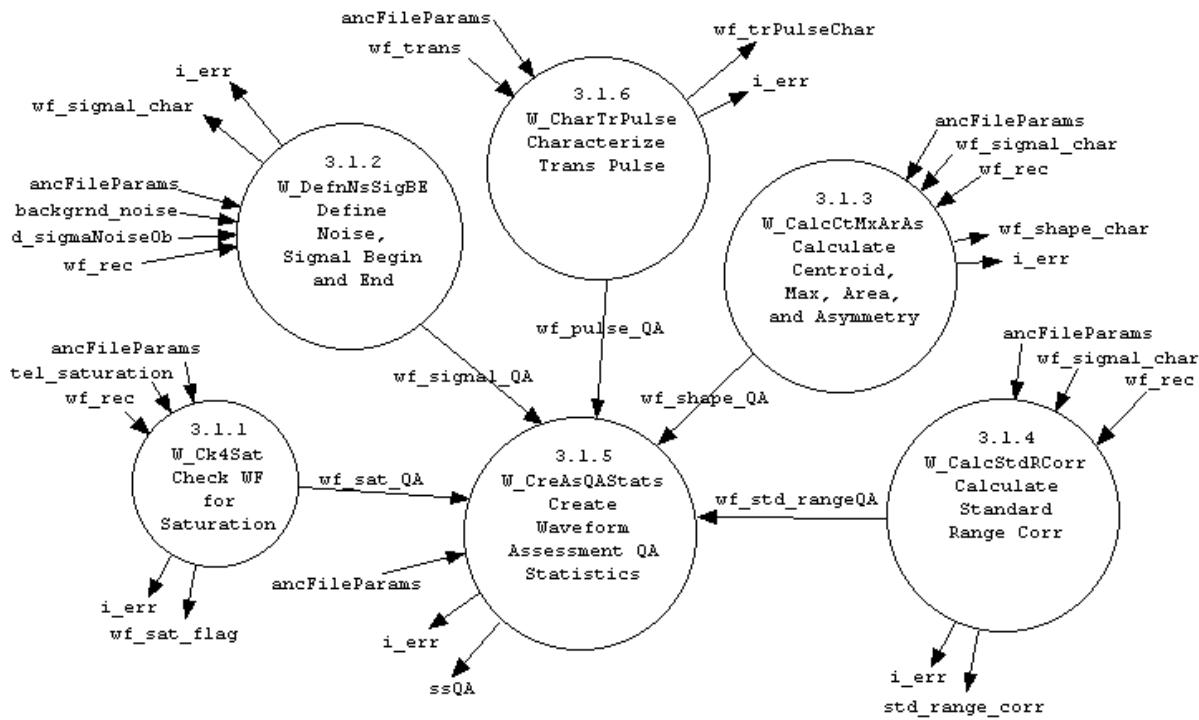
ssQA includes for ice sheet and land products: the percent of measurements for which no signal could be found; for measurements where a signal was found - the percent of measurements that could not be processed due to saturation; and histograms of the skewness of each single pulse return and the percent of saturated signal compared to real signal within each waveform from sig\_beg to sig\_end.

gsQA includes ...

othQA includes for all products: the goodness of fit of the Gaussian to the waveforms; for sea-ice, ice sheet and land products: the number of peaks in the smoothed waveforms; for ice sheet and land products for measurements where a signal could be found: the percent of measurements for which the fitting procedure did not converge, a histogram of the differences between the centroid of the smoothed waveform and the centroid of the Gaussian fit to the last peak, and a histogram of the standard deviation of the fit to the raw waveform; for sea-ice products: histograms of the time delays expressed as distances for centroid to center peak, sig\_beg to center peak, sig\_end to center peak; for ocean products: histograms of time delays expressed as distances for centroid to sig\_beg, and centroid to sig\_end.

# DRAFT

## 10.12.1 Assess Waveforms & Calculate Standard Range Corrector Subprocesses



**Assess Waveforms & Calc Std Range Corr DFD**

**Figure 17.**

The Assess Waveforms process is divided into six subprocesses (W\_Ck4Sat, W\_DefnNsSigBE, W\_CharTrPulse, W\_CalcCtMxArAs, W\_CalcStdRCorr, and W\_CreAsQAStats) which perform a general assessment of the waveforms. In addition to assessing the waveforms, subprocesses W\_Ck4Sat, W\_DefnNsSigBE, W\_CharTrPulse, W\_CalcCtMxArAs, and W\_CalcStdRCorr generate QA data (wf\_sat\_QA, wf\_signal\_QA, wf\_shape\_QA, wf\_std\_rangeQA, and wf\_pulse\_QA) which enter subprocess W\_CreAsQAStats, where QA statistics are created for the process (ssQA). Following is a description of each subprocess:

### 10.12.2 Check WF for Saturation (W\_Ck4Sat)

Utilizes the received waveform (wf\_rec) and the telemetered saturation (tel\_saturation) to check for saturation, and sets the saturation flag (wf\_sat\_flag).

### 10.12.3 Define Noise, Signal Begin and End (W\_DefnNsSigBE)

Utilizes the received waveform (wf), background noise (backgrnd\_noise), and the standard deviation of the noise (d\_sigmaNoiseOb) to define the begin and end points of the waveform and other signal characteristics (wf\_signal\_char).

### 10.12.4 Characterize Transmitted Pulse (W\_CharTrPulse)

Utilizes the transmitted pulse (wf\_trans) to determine the transmitted pulse characteristics (wf\_trPulseChar).

### 10.12.5 Calculate Centroid, Max, Area, and Asymmetry (W\_CalcCtMxArAs)

Utilizes the received waveform (wf\_rec) and waveform signal characteristics (wf\_signal\_char) to calculate the centroid, maximum, area, and asymmetry of the waveform (wf\_shape\_char).

# DRAFT

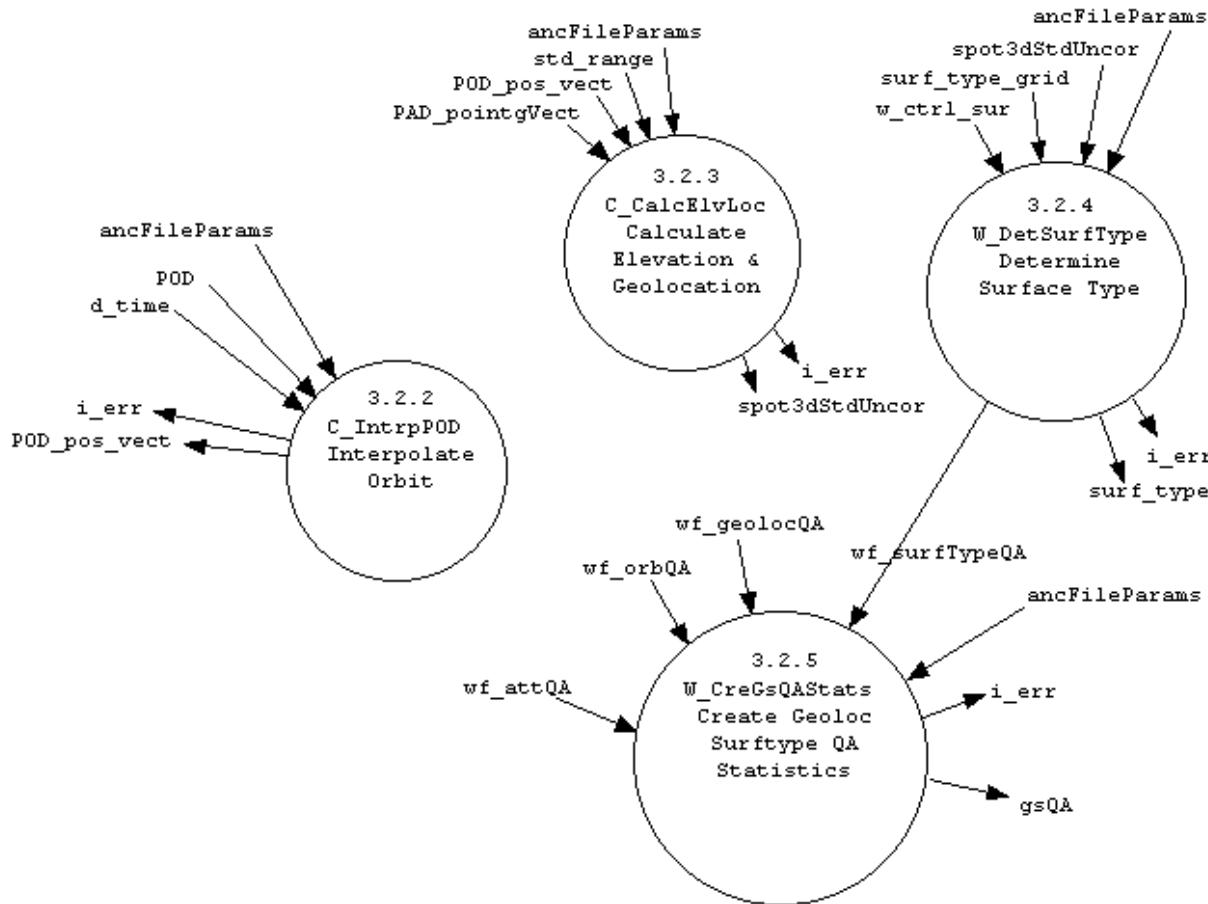
## 10.12.6 Calculate Standard Range Corr (*W\_CalcStdRCorr*)

Utilizes the received waveform (*wf\_rec*) and waveform signal characteristics (*wf\_signal\_char*) to calculate the standard range corrector (*std\_range\_corr*).

## 10.12.7 Create Waveform Assessment QA Statistics (*W\_CreAsQAStats*)

Combines QA data from the previous five processes (*wf\_sat\_QA*, *wf\_signal\_QA*, *wf\_pulse\_QA*, *wf\_shape\_QA*, and *wf\_std\_rangeQA*) to create QA statistics for the process (*ssQA*).

## 10.12.8 Determine Geolocation and Surface Type Subprocesses



**Determine Geolocation and Surface Type DFD**

**Figure 18.**

The Determine Geolocation and Surface Type process is divided into four subprocesses (*C\_IntrpPOD*, *C\_CalcElvLoc*, *W\_DetSurfType*, and *W\_CreGsQAStats*) which determine geolocation and surface type of the spot on the earth where the transmitted pulse is reflected. Each non-utility subprocess is triggered by a control flag (*w\_ctrl\_sur* and *w\_ctrl\_geoQA*) which indicates original processing or a reprocessing scenario. Quality assurance (QA) data for *C\_IntrpPOD* and *C\_CalcElvLoc* is generated by *W\_DetGeoSurTyp* and sent to subprocess *W\_CreGsQAStats*. In addition to determining the surface type, subprocess *W\_DetGeoSurTyp* generates QA data (*wf\_surfTypeQA*) which enters subprocess *W\_CreGsQAStats*, where QA statistics are created for the process (*gsQA*). Following is a description of each subprocess:

# DRAFT

## 10.12.9 Interpolate Orbit (C\_IntrpPOD)

Utilizes the time for the transmitted pulse to return to the instrument (d\_time) and precision orbit data (use POD\_FileInfo to access) to determine the POD fixed position vector (POD\_pos\_vect).

## 10.12.10 Calculate Elevation and Geolocation (C\_CalcElvLoc)

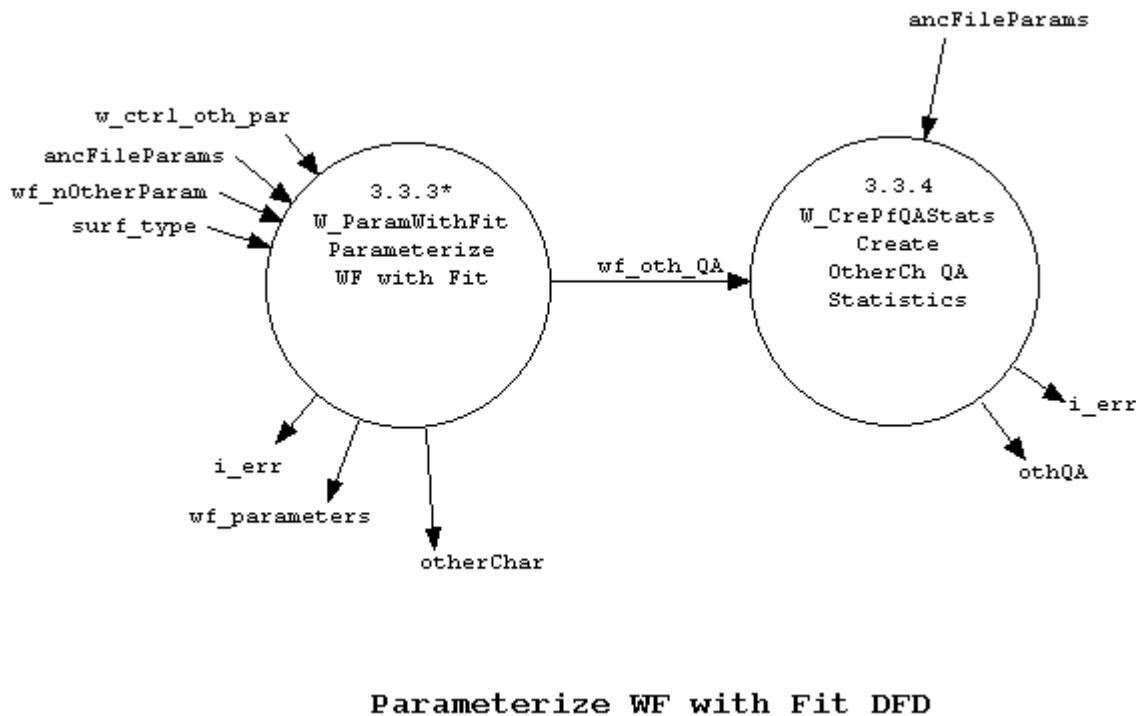
Utilizes precision orbit data (POD\_pos\_vect), precision attitude data (PAD\_pointngVect), time, and the standard range (std\_range) to determine the uncorrected latitude, longitude, and standard elevation (spot3dStdUncor).

## 10.12.11 Determine Surface Type (W\_DetSurfType)

Utilizes the spot location (spot3dStdUncor) and surface type grid (surf\_type\_grid) to determine the surface type (surf\_type).

## 10.12.12 Create Geoloc Surftype QA Statistics (W\_CreGsQAStats)

Combines QA data from the previous four processes (wf\_attQA, wf\_orbQA, wf\_geolocQA and wf\_surfTypeQA) to create QA statistics for the process (gsQA).



**Figure 19.**

### 10.12.12.1 Calculate Other WF Characteristics Subprocesses

The Calculate Other WF Characteristics process is divided into two subprocesses (*W\_ParamWithFit* & *W\_CrePfQAStats*) which calculate other waveform parameters. *W\_ParamWithFit* is triggered by a control (*wf\_ctrl\_oth*) which indicates original processing or a reprocessing scenario. In addition to calculating data parameters, subprocess *W\_ParamWithFit* generates QA data (*wf\_oth\_QA*) which enters subprocess *W\_CrePfQAStats*, where QA statistics are created for the process (othQA). Following is a description of each subprocess:

## 10.12.13 Parameterize WF with Fit (W\_ParamWithFit)

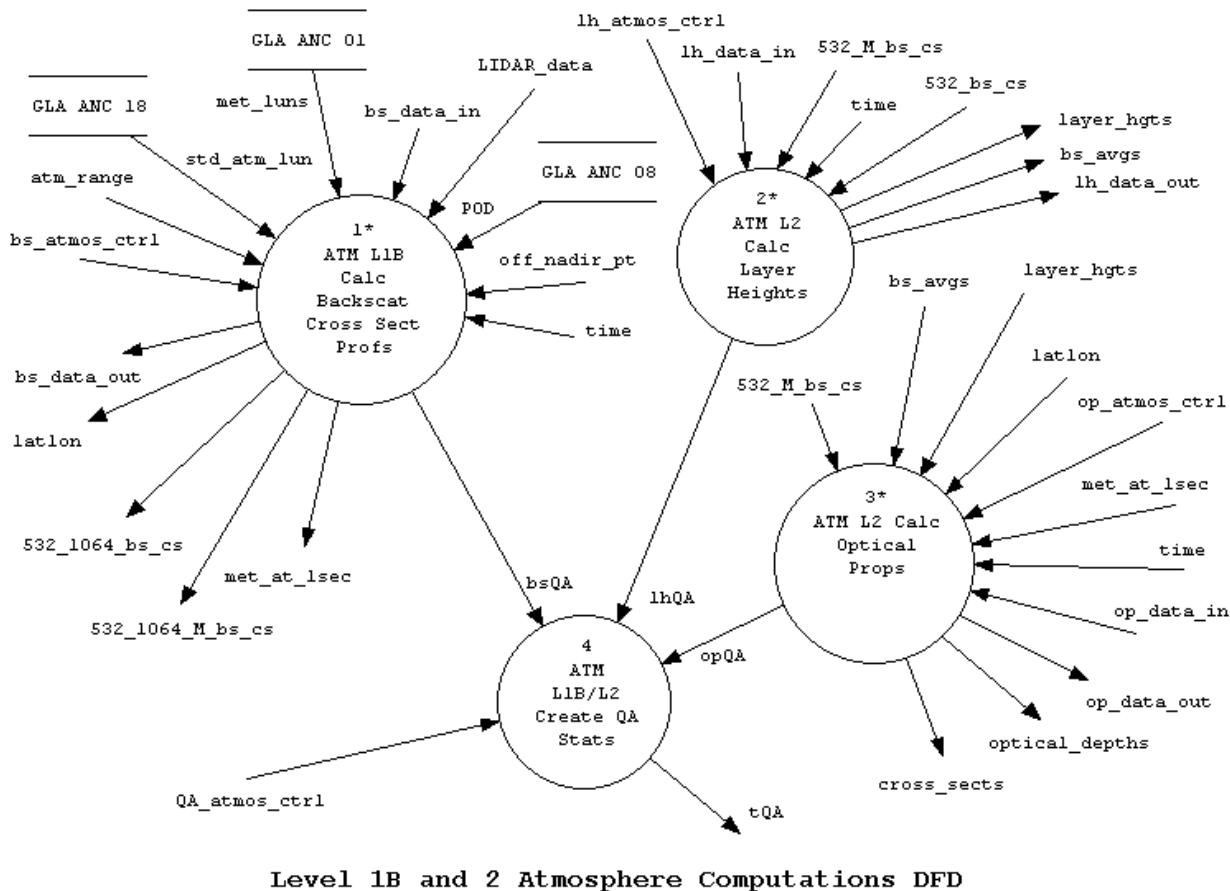
Utilizes the waveform and waveform parameters (*wf\_nOtherParam*) to fit the waveform to a function and return the calculated waveform function parameters (*wf\_parameters*) and other waveform characteristics (*otherChar*).

# DRAFT

## 10.12.14 OtherCh QA Statistics (*W\_CalcPfQAStats*)

Utilizes QA data from the previous process (wf\_oth\_QA) to create QA statistics for the process (othQA).

## 10.13 Level 1B and 2 Atmosphere



**Figure 20.**

The function of the Levels 1B and 2 Atmosphere Computations subsystem is to create atmosphere parameters for the standard data products and to generate associated metadata and quality assessment (QA) data.

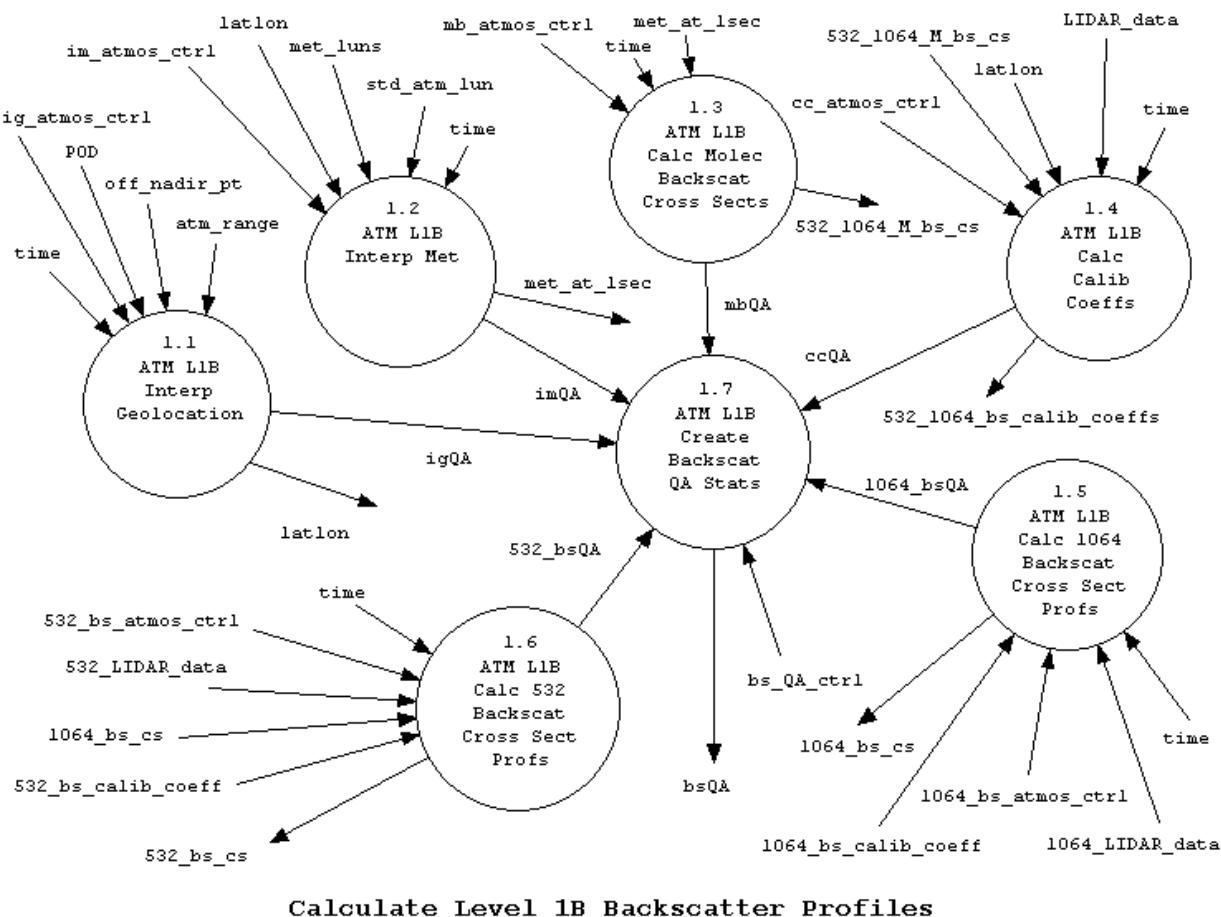
The function of the ATM L1B Calculate Backscatter Cross Section Profiles process is to create parameters for the Level 1B calibrated backscatter product GLA07\_SCF. This process geolocates the data and creates the attenuated backscatter cross section profiles. It utilizes the lidar output from GLA02 and data from ancillary files GLA ANC 01: meteorological (met) data, GLA ANC 18: standard atmosphere (std atm) data, GLA ANC 08: precision orbit determination (POD) and off-nadir (attitude) data.

The function of the ATM L2 Calculate Layer Heights process is to create parameters for the Level 2 aerosol layer height product GLA08\_SCF and the Level 2 cloud layer height product GLA09\_SCF. This process determines, at several resolutions, the top and bottom elevations of multiple aerosol and cloud layers, ground detections, and the planetary boundary layer (PBL) height.

The function of the ATM L2 Calculate Optical Properties process is to create parameters for the Level 2 cloud and aerosol backscatter cross section product GLA10\_SCF and the Level 2 optical depth product GLA11\_SCF. This process creates cross section profiles for cloud and aerosol backscatter and extinction as well as optical depths for the cloud and aerosol layers.

In addition to producing product parameters, the processes generate QA data which enter the ATM L1B/L2 Create QA Statistics process, where QA statistics are compiled for the subsystem for inclusion in the summary information product GLA ANC 06.

# DRAFT



**Figure 21.**

The A\_bscs\_profs process is divided into seven subprocesses. Each subprocess is triggered by a control flag. Following is a description of each subprocess:

#### 10.13.1 ATM L1B Interpolate Geolocation (*A\_intrp\_geoloc*)

Utilizes POD, time, range (atm\_range), and an off-nadir pointing vector (off\_nadir\_pt) to generate profile location (latlon) at 1 second.

#### 10.13.2 ATM L1B Interpolate Met Data (*A\_interp\_met*)

Utilizes profile location (latlon) and time to interpolate met data (met\_luns) and std atm data (std\_atm\_lun) to 1 second (met\_at\_1sec).

#### 10.13.3 ATM L1B Calculate Molecular Backscatter Cross Sections (*A\_mbcs*)

Utilizes met data and std atm data at 1 second (met\_at\_1sec) and time to create molecular backscatter cross section profiles at 532 nm and 1064 nm at 1 second (532\_1064\_M\_bs\_cs).

#### 10.13.4 ATM L1B Calculate Calibration Coefficients (*A\_cal\_cofs*)

Utilizes molecular backscatter section profiles at 532 nm and 1064 nm (532\_1064\_M\_bs\_cs), profile location (latlon), time, and normalized LIDAR signals at 532 nm at 1 and 40 Hz and at 1064 nm at 5 and 40 Hz (LIDAR\_data) to create backscatter calibration coefficients at 532 nm and 1064 nm (532\_1064\_bs\_calib\_coeffs).

# DRAFT

## 10.13.5 ATM L1B Calculate 1064 Backscatter Cross Section Profiles (A\_ir\_bscs)

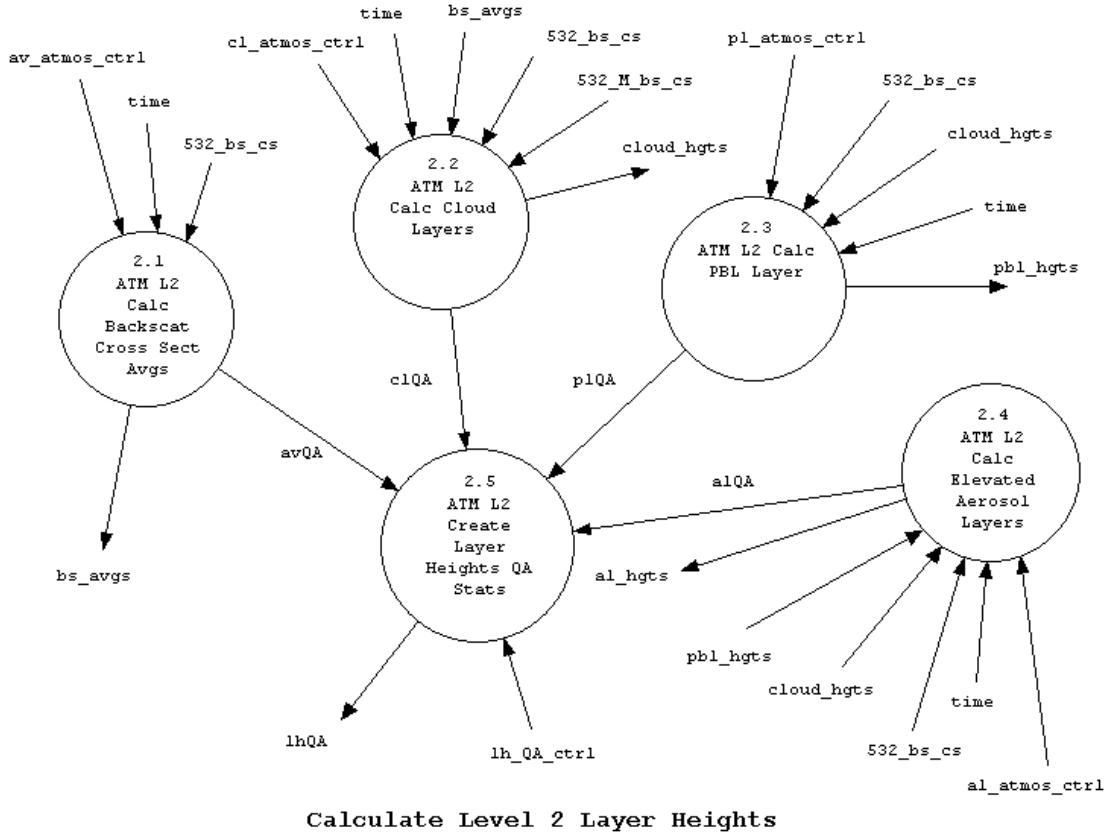
Utilizes a backscatter calibration coefficient at 1064 nm (1064\_bs\_calib\_coeff), time, and normalized LIDAR signals at 1064 nm at 5 and 40 Hz (1064\_LIDAR\_data) to create attenuated backscatter cross section profiles at 1064 nm at 5 and 40 Hz (1064\_bs\_cs). It will be an option to either use the backscatter calibration coefficient calculated in subprocess A\_cal\_cofs or to use a lab measured constant coefficient instead, since the calculated coefficient may be unreliable due to low signal at high altitude.

## 10.13.6 ATM L1B Calculate 532 Backscatter Cross Section Profiles (A\_g\_bscs)

Utilizes the backscatter calibration coefficient at 532 nm (532\_bs\_calib\_coeff), normalized LIDAR signals at 532 nm at 1, 5, and 40 Hz (532\_LIDAR\_data), time, and attenuated backscatter cross section profiles at 1064 nm at 5 and 40 Hz (1064\_bs\_cs) to create merged attenuated backscatter cross section profiles at 532 nm at 5 and 40 Hz (532\_bs\_cs). If the LIDAR signal at 532 nm is saturated, then the cross section profile at 1064 nm is converted into a cross section profile at 532 nm.

## 10.13.7 ATM L1B Create Backscatter QA Statistics (A\_bs\_qa\_stats)

Combines QA output from the preceding six subprocesses (igQA, imQA, mbQA, ccQA, 1064\_bsQA, and 532\_bsQA) to create backscatter QA statistics (bsQA). These statistics will include time-sampled cross section profiles for browsing. Also, the calibration coefficients and laser energies will be plotted vs. time as a QA statistic.



**Figure 22.**

The A\_lay\_hts process is divided into five subprocesses. Each subprocess is triggered by a control flag. Following is a description of each subprocess:

## 10.13.8 ATM L2 Calculate Backscatter Cross Section Averages (A\_avg\_bscs)

Utilizes merged attenuated backscatter cross section profiles at 532 nm (532\_bs\_cs) and time to create 1 second and 4 second averages (bs\_avgs).

# DRAFT

## 10.13.9 ATM L2 Calculate Cloud Layers (A\_cld\_lays)

Utilizes 1 second and 4 second merged attenuated backscatter cross section profile averages at 532 nm (bs\_avgs), molecular backscatter cross section profiles at 532 nm (532\_M\_bs\_cs), time, and merged attenuated backscatter cross section profiles at 532 nm at 5 and 40 Hz (532\_bs\_cs) to create cloud layer heights and ground detections at 4 sec and 1, 5 and 40 Hz (cloud\_hgts).

## 10.13.10 ATM L2 Calculate PBL Layer (A\_pbl\_lay)

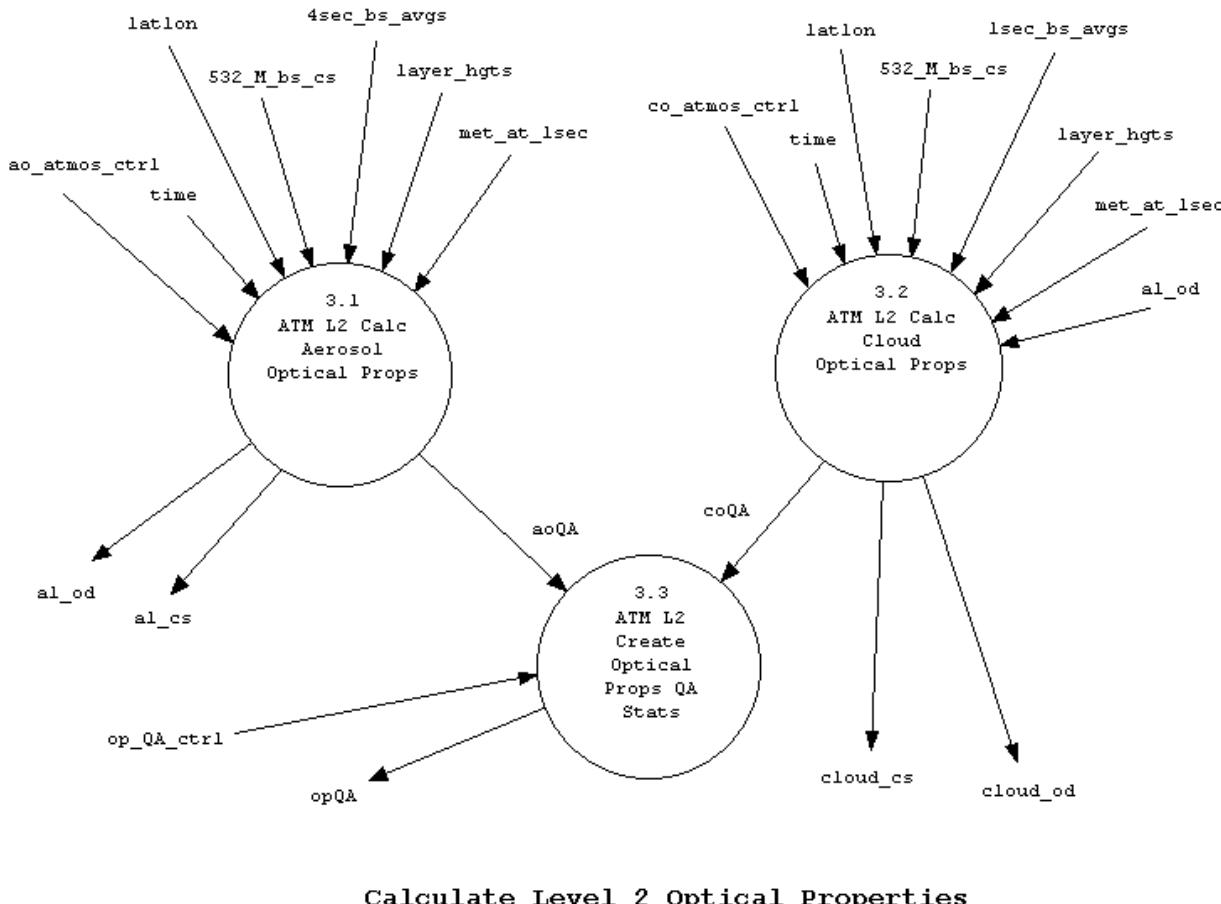
Utilizes merged attenuated backscatter cross section profiles at 532 nm at 5 Hz (532\_bs\_cs), time, and cloud layer heights and ground detections at 4 sec and 5 Hz (cloud\_hgts) to create PBL heights and ground detections at 4 sec and 5 Hz (pbl\_hgts).

## 10.13.11 ATM L2 Calculate Elevated Aerosol Layers (A\_aer\_lays)

Utilizes time, merged attenuated backscatter cross section profiles at 532 nm at 5 Hz (532\_bs\_cs), cloud layer heights and ground detections at 4 sec (cloud\_hgts), and PBL heights and ground detections at 4 sec (pbl\_hgts) to create elevated aerosol layer heights at 4, 20 sec (al\_hgts).

## 10.13.12 ATM L2 Create Layer Heights QA Statistics (A\_lh\_qa\_stats)

Combines QA output from the preceding four subprocesses (avQA, clQA, plQA, and alQA) to create layer height QA statistics (lhQA). These statistics will include time-sampled cloud and aerosol layers (time vs. height) for browsing.



**Figure 23.**

The A\_opt\_props process is divided into three subprocesses. Each subprocess is triggered by a control flag. Following is a description of each subprocess:

# DRAFT

## 10.13.13 ATM L2 Calculate Aerosol Optical Properties (A\_aer\_opt\_prop)

Utilizes met data and std atm data at 1 second (met\_at\_1sec), profile location (latlon), 4 second merged attenuated backscatter cross section profile averages at 532 nm (4sec\_bs\_avgs), molecular backscatter cross section profiles at 532 nm (532\_M\_bs\_cs), time, cloud and PBL layer heights and ground detections at 4 sec, and aerosol layer heights at 4 and 20 sec (layer\_hgts) to create aerosol cross section profiles at 4 sec (al\_cs) and aerosol optical depths at 4 sec (al\_od).

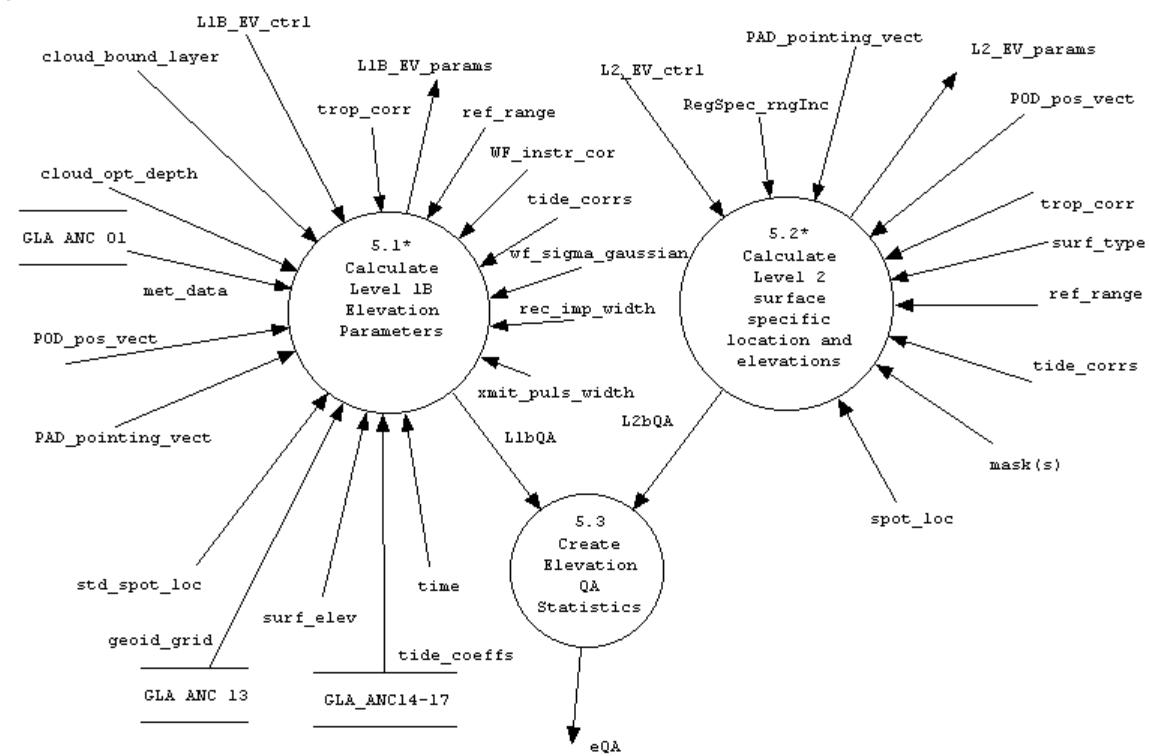
## 10.13.14 ATM L2 Calculate Cloud Optical Properties (A\_cld\_opt\_prop)

Utilizes met data and std atm data at 1 second (met\_at\_1sec), profile location (latlon), 1 second merged attenuated backscatter cross section profile averages at 532 nm (1sec\_bs\_avgs), molecular backscatter cross section profiles at 532 nm (532\_M\_bs\_cs), time, cloud layer heights and ground detections at 1 and 4 sec, PBL layer heights and ground detections at 4 sec, and aerosol layer heights at 4 sec (layer\_hgts), and aerosol optical depths at 4 sec (al\_od) to create cloud cross section profiles at 1 sec (cloud\_cs) and cloud optical depths at 1 sec (cloud\_od).

## 10.13.15 ATM L2 Create Optical Properties QA Statistics (A\_op\_qa\_stats)

Combines QA output from the preceding two subprocesses (coQA and aoQA) to create optical properties QA statistics (opQA).

## 10.14 Level 1B and 2 Elevation

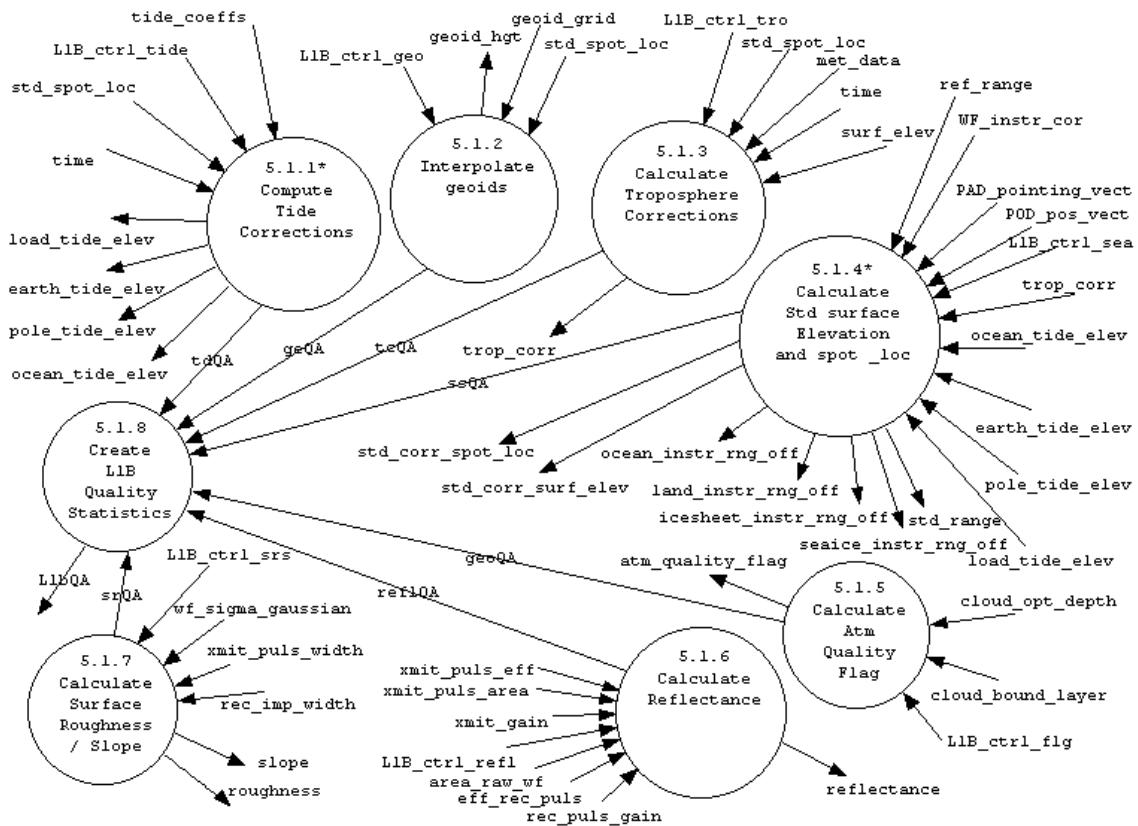


**Level 1B and 2 Elevation DFD**

**Figure 24. Level 1B and 2 Elevation DFD**

The Levels 1B and 2 Elevation Computation subsystem generates all elevation Standard Data Products, associated Processing Quality Assessment data, and related computations. The Level 1B subsystem creates parameters for a Level 1B time-ordered global product (GLA06\_SCF) with a geodetically corrected surface-independent standard elevation. The Level 2 subsystem determines region specific (ice sheet, sea ice, land, and ocean regions) elevation parameters for Level 2 time-ordered regional products (GLA12\_SCF, GLA13\_SCF, GLA14\_SCF, and GLAS15\_SCF).

# DRAFT



**Figure 25. Level 1B Elevation Computation DFD**

Each process is triggered by a control flag which indicates original processing or reprocessing. A description of each of the processes is presented below:

#### 10.14.1 Compute Tide Corrections (*E\_getTides*)

Utilizes the tide coefficients (tide\_coeffs), spot location (std\_spot\_loc) and time (time) to calculate the appropriate tide corrections (load\_tide\_elev, ocean\_tide\_elev, earth\_tide\_elev, and pole\_tide\_elev).

#### 10.14.2 Interpolate Geoids (*E\_GetGeoid*)

Utilizes the geoid data (geoid\_grid) and spot location (std\_spot\_loc) to interpolate for the Geoid height (geoid\_hgt).

#### 10.14.3 Calculate Troposphere Corrections (*E\_CalcTrop*)

Interpolates the met data files (met\_data) spatially for a given spot location, and then interpolates the results temporally for the given time. The interpolated parameters are then used in the calculation of the tropospheric corrections (trop\_corr).

#### 10.14.4 Calculate Std surface Elevation and spot loc (*E\_CalcRange*, *C\_CalcRngOff*, *C\_CalcSploc*)

Utilizes the results from the previous three processes along with the spacecraft position in ITRF (POD\_pos\_vect), the laser attitude in ITRF (PAD\_pointing\_vect), refrance range (ref\_range), and waveform parameters (WF\_instr\_corr) to calculate surface independent elevations (std\_corr\_surf\_elev), spot locations (std\_corr\_spot\_loc), as well as land, ocean, seaice and icesheet instrument range offsets (land\_instr\_rng, ocean\_instr\_rng, seaice\_instr\_rng, and icesheet\_instr\_rng), and standard range (std\_range).

# DRAFT

## 10.14.5 Calculate Quality Flag (E\_AtmQF)

Utilizes the cloud optical depth (cloud\_opt\_depth) and cloud boundary layer height (cloud\_bound\_layer) to ascertain the effect of atmospheric problems that would decrease quality of the elevation product. This quality is returned as a flag (geo\_quality\_flag).

## 10.14.6 Calculate Reflectance (E\_CalcRef)

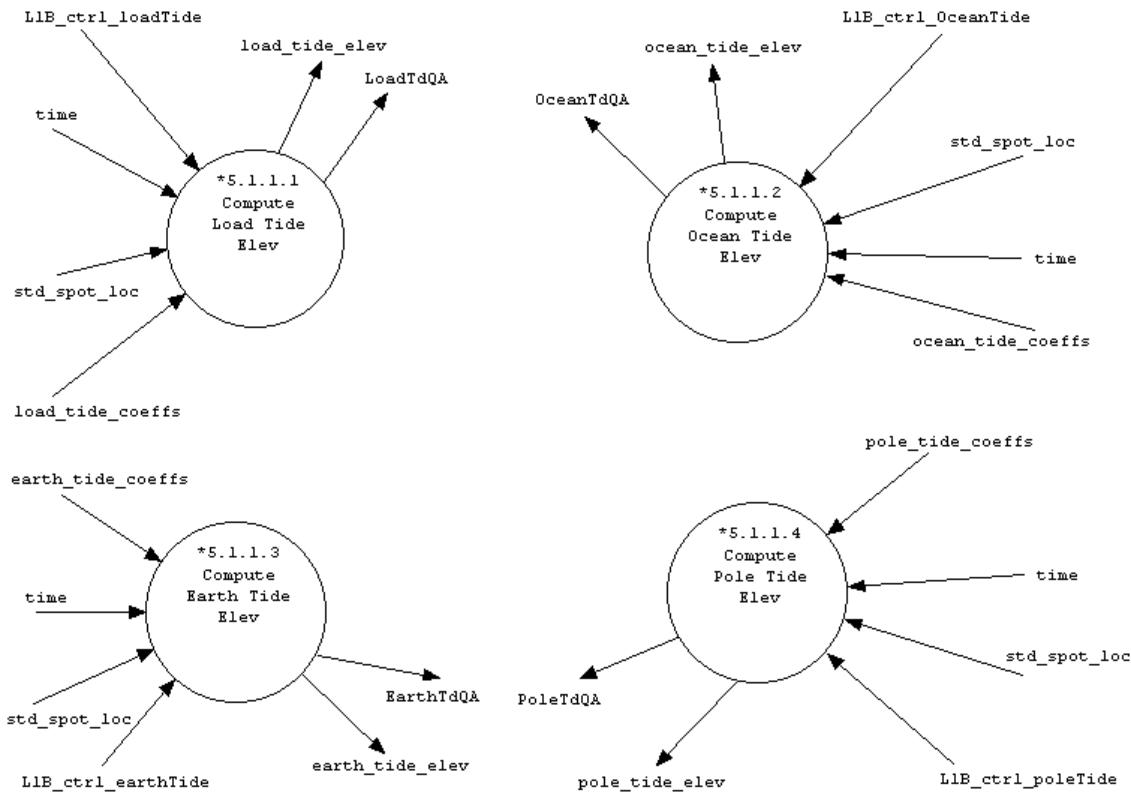
Utilizes the receiver pulse gain (rec\_puls\_gain), efficiency of the received pulse (eff\_rec\_puls), area of raw waveform (area\_raw\_wf), transmit gain (xmit\_gain), transmitted pulse efficiency (xmit\_puls\_eff), and area of transmitted pulse (xmit\_puls\_area) to calculate the reflectance (reflectance).

## 10.14.7 Calculate Slope & Roughness (E\_CalcSlope)

Utilizes the sigma of the gaussian waveform (wf\_sigma\_gaussian), transmited pulse width (xmit\_puls\_width), and receiver impulse width (rec\_imp\_width) to calculate the slope and roughness.

## 10.14.8 Create L1B Quality Statistics

Combines QA data from the previous six processes to create QA statistics for the Level 1B Elevation Computation subsystem



**Figure 26. Compute Tide Corrections DFD**

The Compute Tide Corrections process consists of four subprocesses (5.1.1.1 - 5.1.1.4) which calculates the elevation corrections due to the effects of the load tide, ocean tide, earth tide, and pole tide. Each subprocess is triggered by a control flag. Following is a brief description of each of the subprocesses:

### 10.14.8.1 Compute Load Tide Correction

Utilizes the load tide coefficients file (load\_tide\_coeffs) to compute the coefficients for the given spot location (std\_spot\_loc). Then calculates the load tide correction (load\_tide\_corr) using the given time (time).

### 10.14.8.2 Compute Ocean Tide Correction

Utilizes the ocean tide coefficients file (ocean\_tide\_coeffs) to compute the coefficients for the given spot location (std\_spot\_loc). Then calculates the ocean tide correction (ocean\_tide\_corr) using the given time (time).

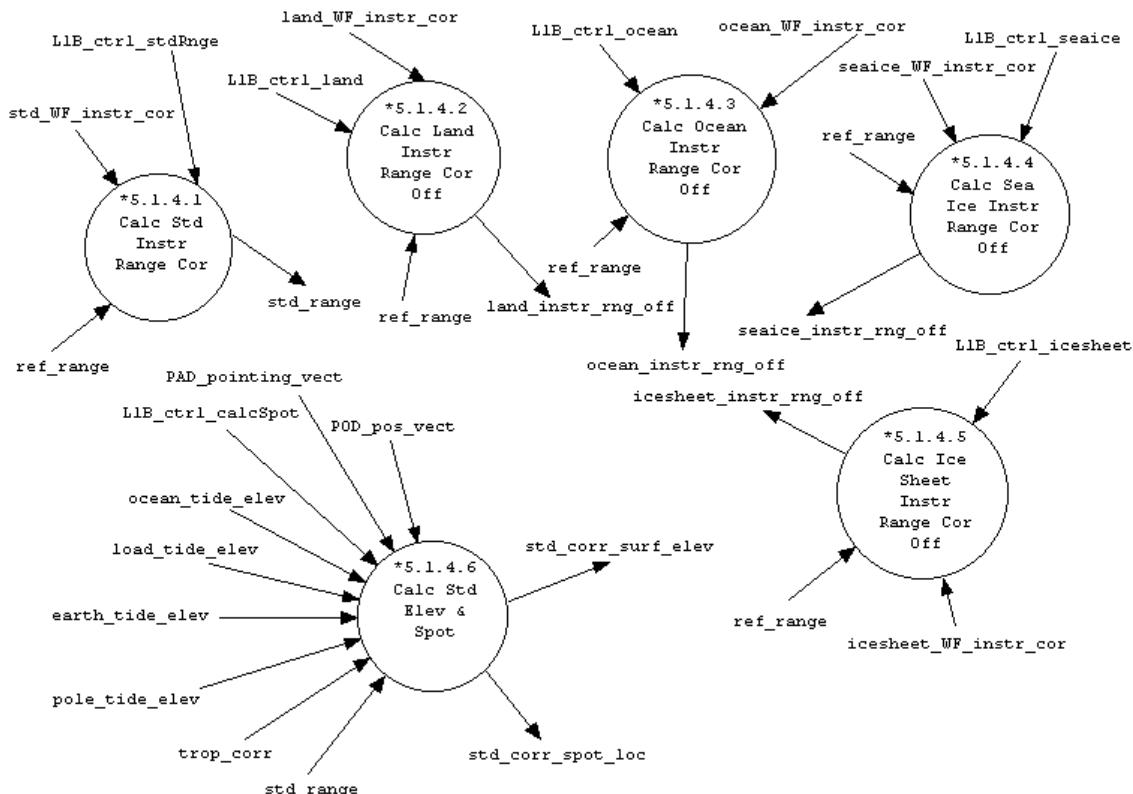
# DRAFT

### 10.14.8.3 Compute Earth Tide Correction

Utilizes the earth tide coefficients file (earth\_tide\_coeffs) to compute the coefficients for the given spot location (std\_spot\_loc). Then calculates the earth tide correction (earth\_tide\_corr) using the given time (time).

### 10.14.8.4 Compute Pole Tide Correction

Utilizes the pole tide coefficients file (pole\_tide\_coeffs) to compute the coefficients for the given spot location (std\_spot\_loc). Then calculates the pole tide correction (pole\_tide\_corr) using the given time (time).



**Figure 27. Calculate Std Surface Elevation and Spot Loc DFD**

The Calculate Std Surface Elevation and Spot Loc process consists of six subprocesses (8.14.8.5 – 8.14.8.10). These processes determine the standard range and the four surface specific (land, ocean, seaice, and icesheet) instrument range offsets. Each subprocess is triggered by a control flag. Following is a brief description of each of the subprocesses:

### 10.14.8.5 Calc Std Instr Range (E\_CalcRange)

Utilizes the standard waveform instrument corrections (std\_WF\_instr\_cor), and reference range (ref\_range) to calculate the standard instrument range (std\_range).

### 10.14.8.6 Calc Land Instr Range (C\_CalcrngOff)

Utilizes the land waveform instrument corrections (land\_WF\_instr\_cor), and reference range (ref\_range) to calculate the land instrument range offset (land\_instr\_rng).

### 10.14.8.7 Calc Ocean Instr Range (C\_CalcrngOff)

Utilizes the ocean waveform instrument corrections (ocean\_WF\_instr\_cor), and reference range (ref\_range) to calculate the ocean instrument range offset (ocean\_instr\_rng).

### 10.14.8.8 Calc Sea Ice Instr Range (C\_CalcrngOff)

Utilizes the sea ice waveform instrument corrections (seaice\_WF\_instr\_cor), and reference range (ref\_range) to calculate the sea ice instrument range offset (seaice\_instr\_rng).

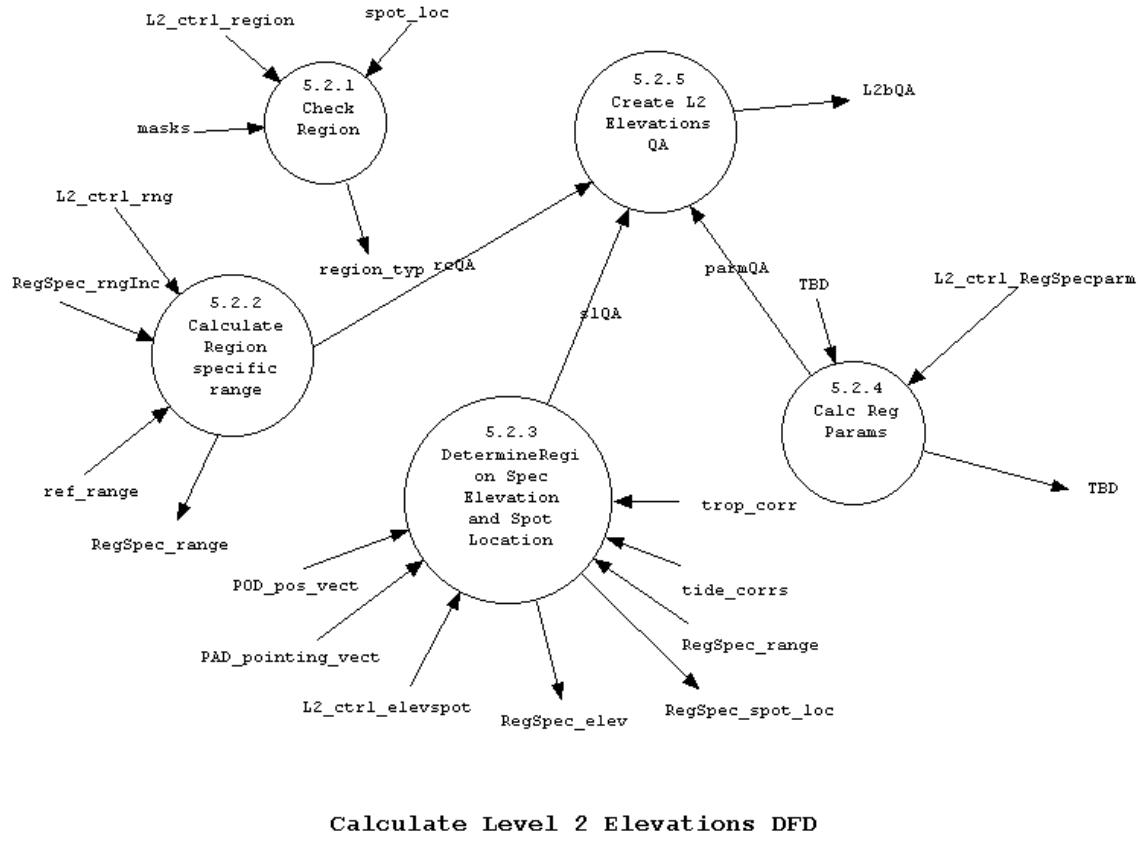
### 10.14.8.9 Calc Ice Sheet Instr Range (C\_CalcrngOff)

Utilizes the icesheet waveform instrument corrections (icesheet\_WF\_instr\_cor), and reference range (ref\_range) to calculate the ice sheet instrument range offset (icesheet\_instr\_rng)..

# DRAFT

## 10.14.8.10 Calc Std Elev & Spot (C\_CalcSploc)

Utilizes the standard range (std\_range), troposphere corrections (trop\_corr), tide corrections (earth, ocean, pole, and load), spacecraft position in ITRF (POD\_pos\_vect), and laser attitude in ITRF (PAD\_pointing\_vect) to calculate the surface independent spot location (std\_corr\_spot\_loc) and surface elevation (std\_corr\_surf\_elev) relative to a predetermined



ellipsoid.

**Figure 28. Calculate Level 2 Elevations DFD**

The Level 2 Elevation Computation subsystem consists of five processes (8.14.9 – 8.14.13). A description of each of the processes is presented below:

### 10.14.9 Check Region (E\_ChkReg)

Utilizes the region masks (masks) and spot location (spot\_loc) to determine if the data lies in a valid region (region\_typ).

### 10.14.10 Calculate Region Specific Range (E\_CalcRange)

Utilizes the region specific instrument range increments (RegSpec\_rngInc) and reference range (ref\_range) to calculate a region specific range (RegSpec\_range).

### 10.14.11 Determine Region Spec Elevation and Spot Location (C\_CalcSploc)

Utilizes the region specific range (RegSpec\_range), POD position vector (POD\_pos\_vect), PAD vectors (PAD\_pointing\_vect), tide corrections (tide\_corr), and trop corrections (trop\_corr) to calculate the surface specific elevation (surf\_spec\_elevation) and spot location (spot\_loc)

### 10.14.12 Calc Reg Params (E\_CalcRegParm)

TBD

# DRAFT

## 10.14.13 Create L2 Elevations QA (E\_CreateL2QA)

Combines QA data from the processes 5.2.2, 5.2.3, and 5.2.4 (E\_CalcRange, C\_CalcSploc,

## 11 Dynamic Model(State Transition diagrams)

### 11.1 The I-SIPS Controller

#### 11.1.1 The Executor

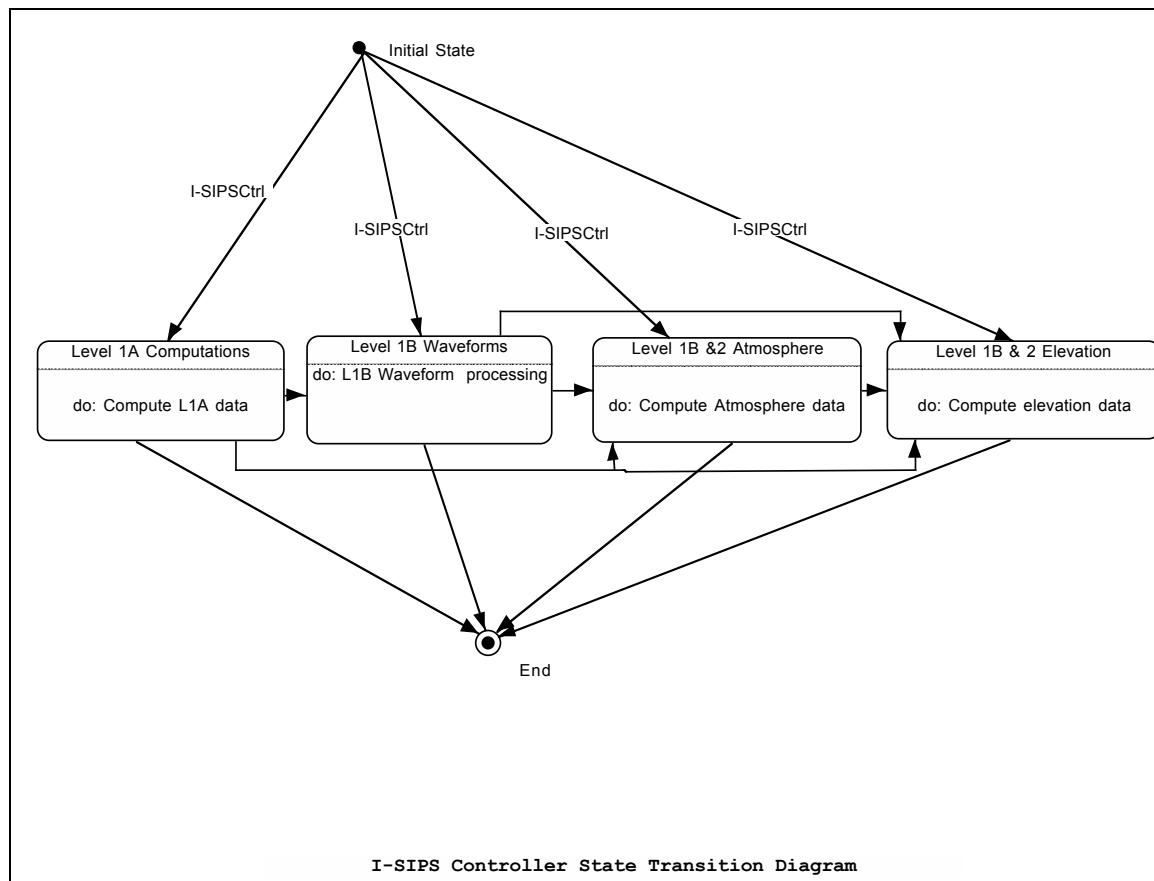


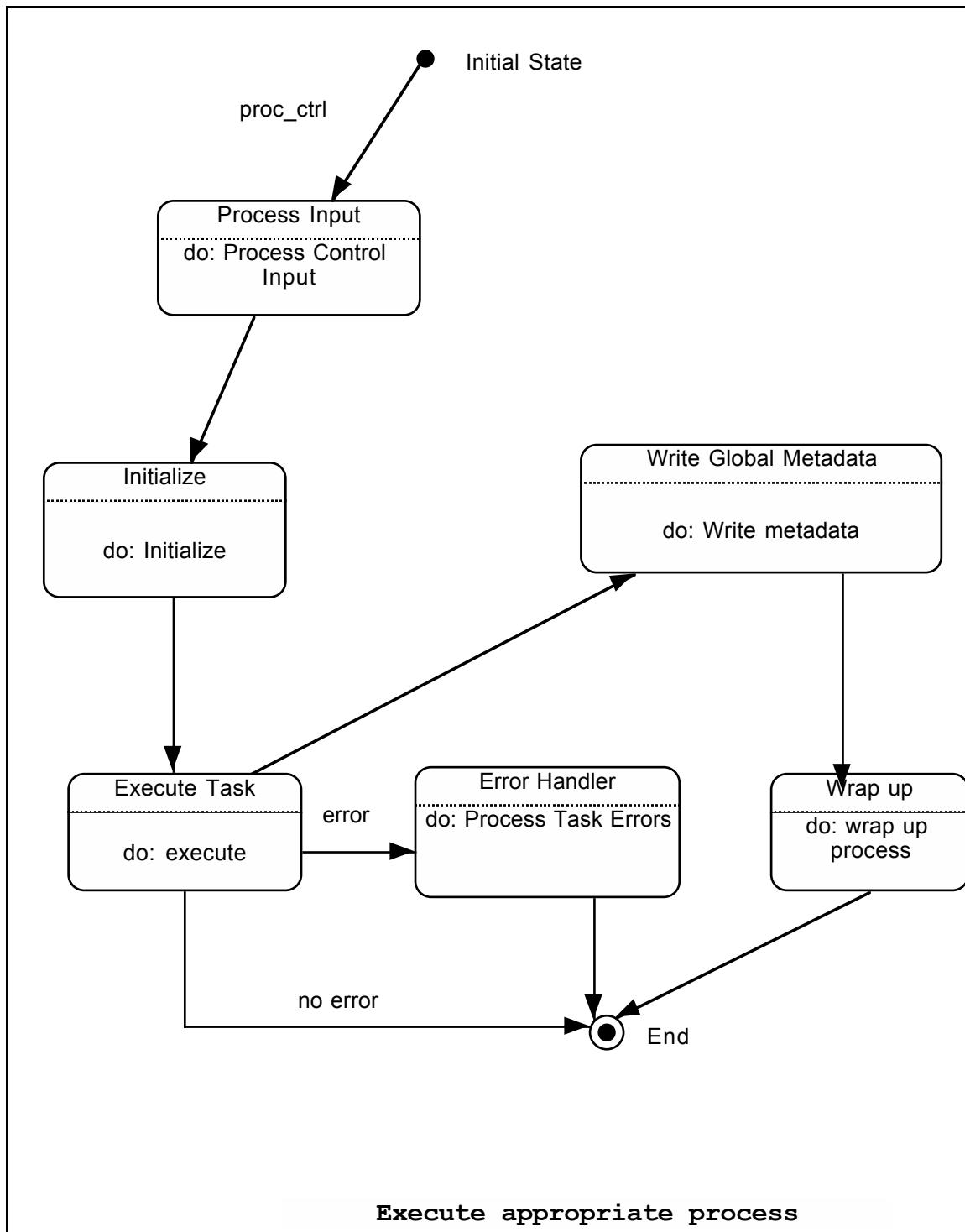
Figure 29.

# DRAFT

**Table 2. GLAS\_Exec**

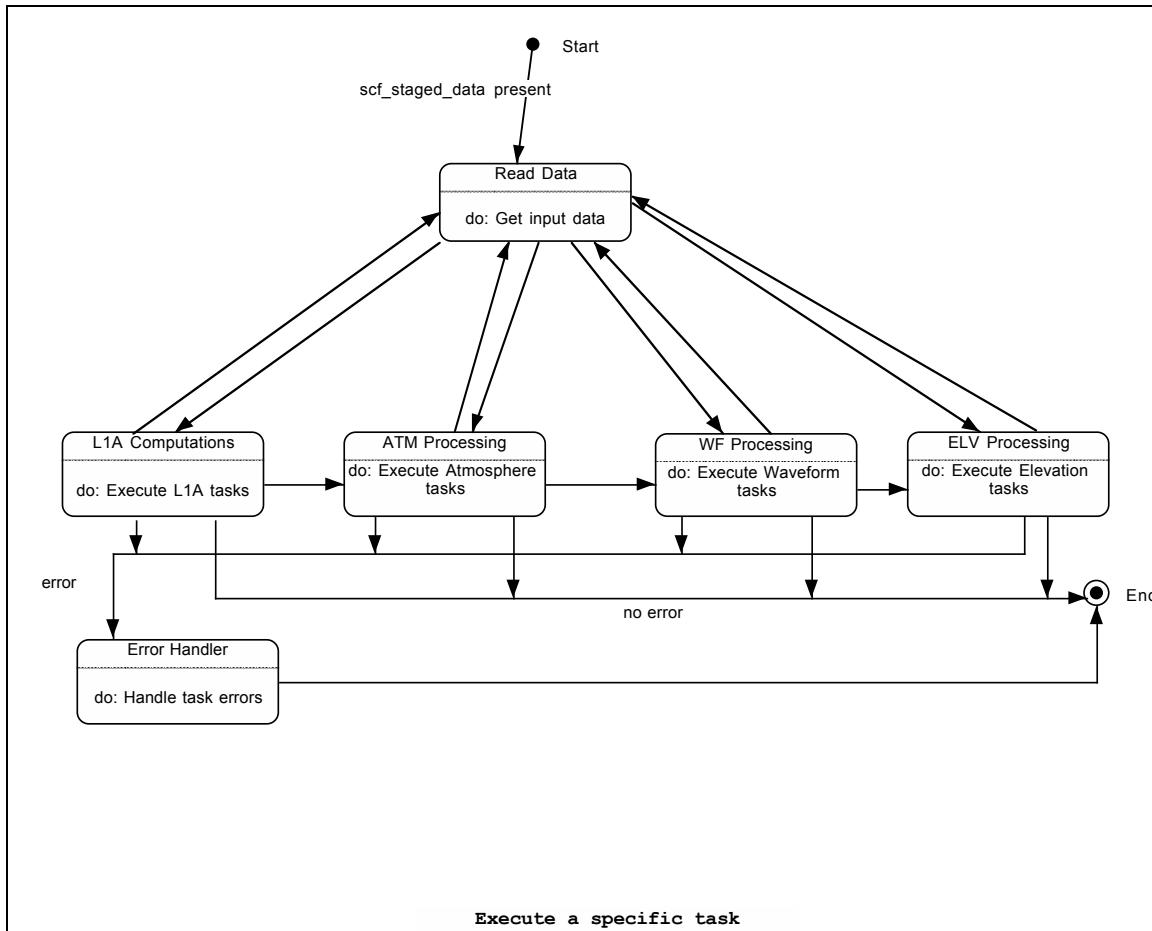
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Change in L1A Computations	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1
Change in L1B Waveforms	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1
Change in L1B and 2 Atmosphere	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1
Change in L1B and 2 Elevation	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1
Action															
Execute L1A Processes	x	x		x		x		x		x		x		x	x
Excite L1B Waveform processes	x		x	x			x	x			x	x			x
Execute L1B and 2 Atmosphere Processes	x				x	x	x	x					x	x	x
Execute L1B and 2 Elevation Processes	x								x		x	x	x	x	x

# DRAFT



**Figure 30.**

# DRAFT



**Figure 31.**

### 11.1.2 Data Preparation, Formatting, Archiving

This section will not be developed for Version 0.

### 11.2 Level 1A Computations

II. Decision Table for the Level 1A Computations

# DRAFT

**Table 3.**

Var	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ALT ATBD input or code updates	Y	Y	Y	Y	N	N	N	N	N	Y	N	Y	N	Y	Y	N
ATM ATBD input or code updates	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	N	Y	N
ENG ATBD input or code updates	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	Y	N	N
ATT ATBD input or code updates	N	N	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	N	Y	N
Actions																
Do ALT ATBD	X	X	X	X		X	X	X	X	X		X		X	X	
Do ATM ATBD		X	X	X	X	X	X	X	X	X			X	X	X	
Do ENG ATBD	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Do ATT ATBD			X	X		X	X	X	X	X	X	X	X	X	X	
Do QA Stats	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

The variables in the Level 1A processing are updated inputs or updated software. Updated inputs will occur if missing packets are recovered or ancillary data is updated. Updated software will occur if algorithms are modified or code errors are corrected.

An entire ATBD will be executed for any update related to that ATBD. The QA Stats process will always be executed if an ATBD is re-run.

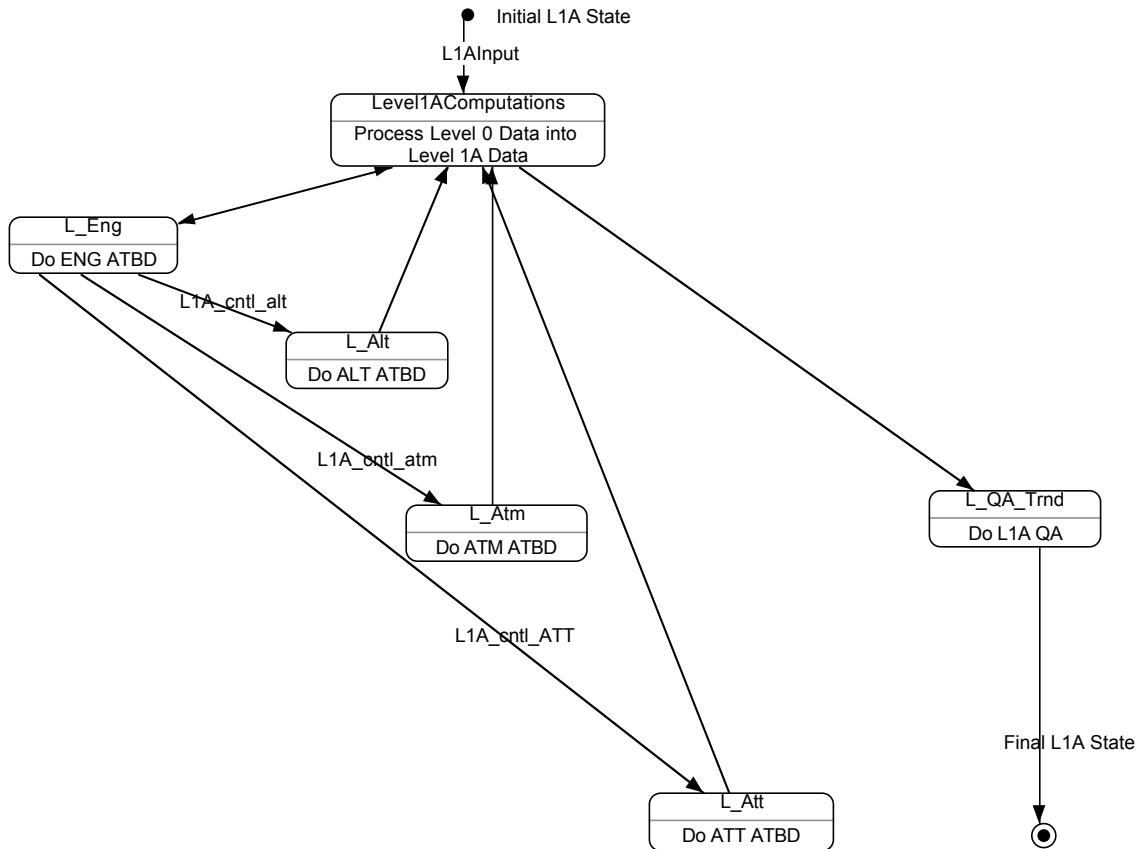
The 4 individual scenarios are:

1. The input to the altimeter ATBD is updated or the ALT ATBD software is modified.
2. The input to the atmosphere ATBD is updated or the ATM ATBD software is modified.
3. The input to the engineering ATBD is updated or the ENG ATBD software is modified.
4. The input to the attitude ATBD is updated or the ATT ATBD software is modified.

The decision table lists all the possible combinations of individual scenarios. Since some of the processing in the ALT, ATM, and ATT ATBDs is dependent on engineering data that is output from the ENG ATBD, the ENG ATBD will be executed first and any time the engineering data is re-processed the ALT, ATT, and ATM ATBDs will be executed. The Level 1A data will always be re-created from the Level 0 data. Therefore, for any reprocessing scenario the Level 1A engineering ATBD will always be executed since the other ATBDs rely on Level 1A engineering data as input. The ALT, ATM, and ATT ATBDs are not dependent on each other and can be executed in any order or concurrently.

### III. State Diagram

# DRAFT

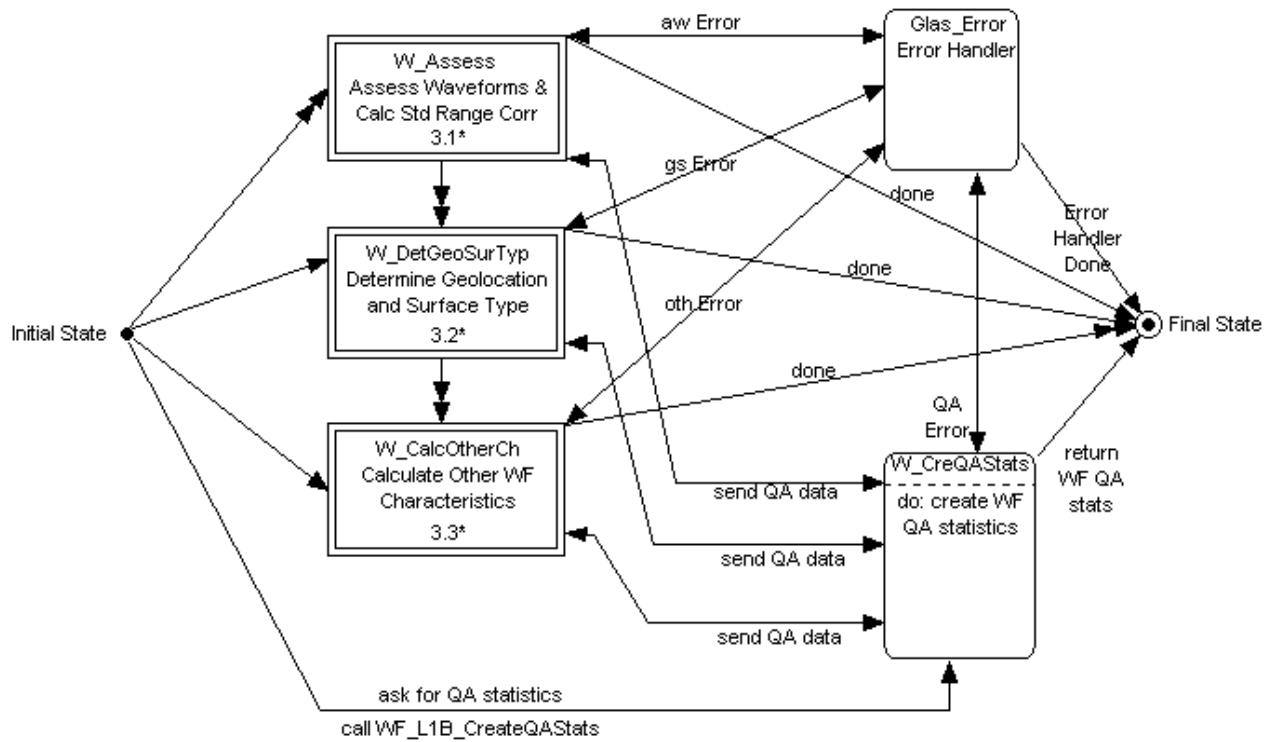


**Figure 32.**

The state diagram shows that the L\_Eng is called for every scenario. Then, depending on the control values, the other ATBDs are called. Each of the ATBDs returns to the manager. The QA/Trend processing is called last.

### 11.3 Level 1B Waveforms

# DRAFT

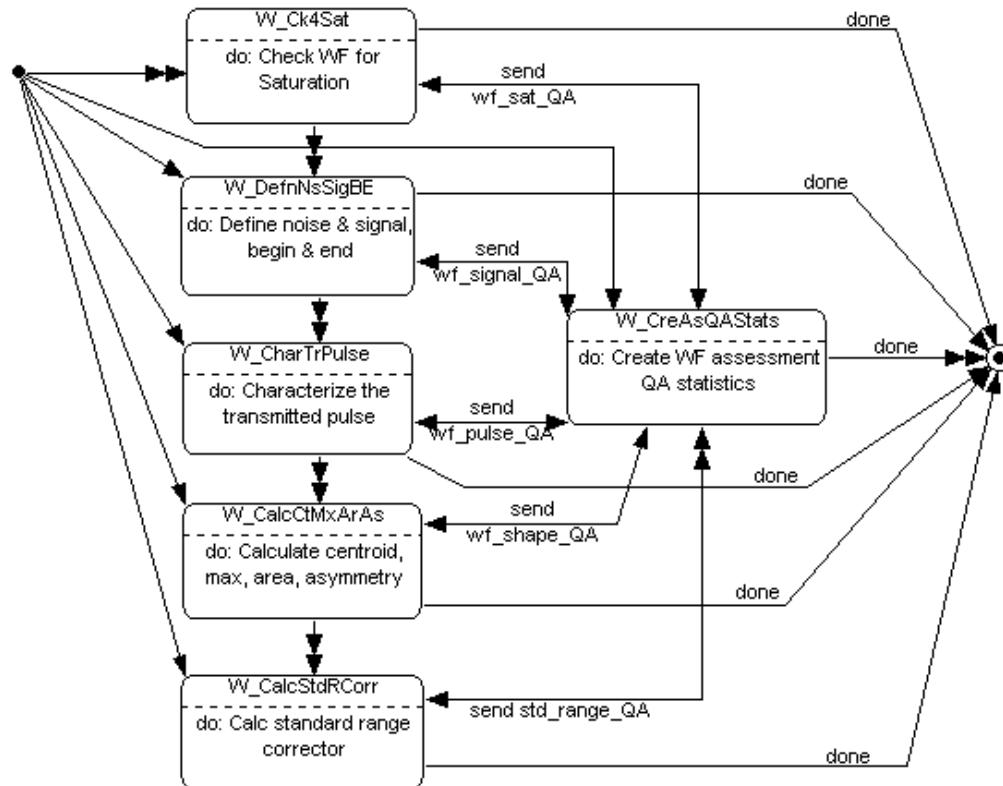


**Level 1B Waveforms State Diagram**

**Figure 33. State Model (State Transition Diagrams)**

The normal sequence of processes is indicated with double arrows. The waveforms will be assessed and the standard range corrector will be calculated (W\_Assess); the geo-location and the surface type will be determined (W\_DetGeoSurTyp); and then other waveform characteristics will be calculated such as parameterizing the waveform (W\_CalcOtherCh). This sequence will continue for each record. When processing is completed, the Quality Assurance (QA) statistics will be created (W\_CreQAStats) and returned to the waveform manager (WF\_Manager). All waveform subprocesses will call GLAS\_Error if an error is detected, but it will not be shown on any other diagram.

# DRAFT

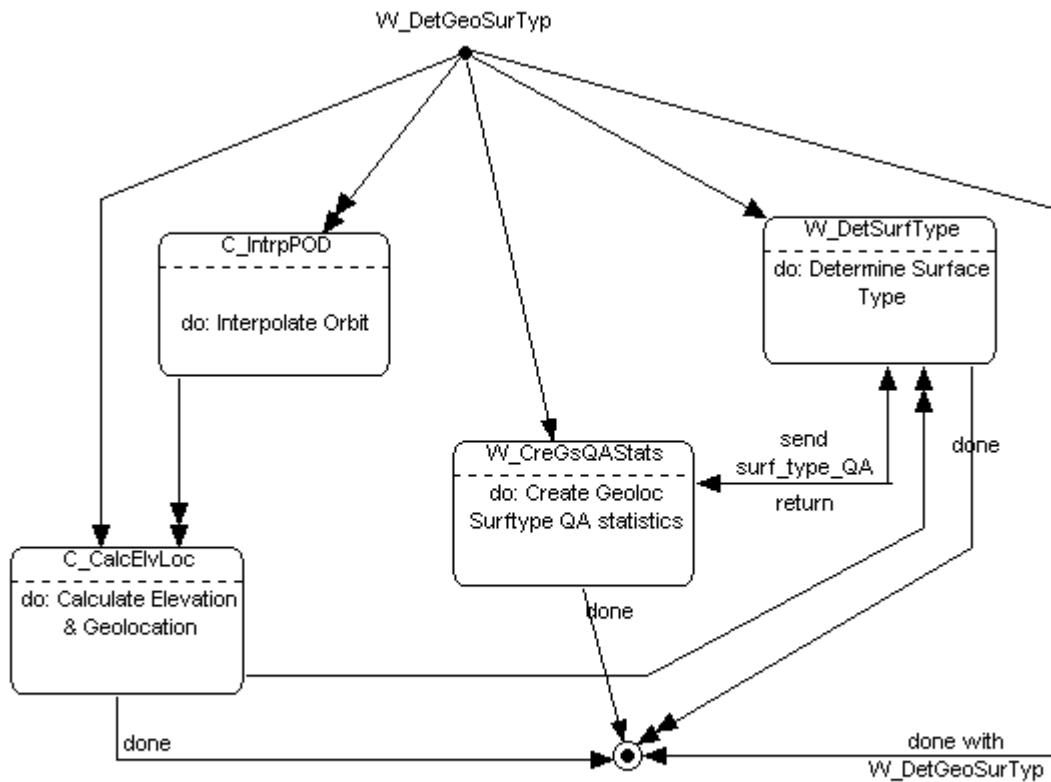


**Assess Waveforms & Calculate Std Range Corr State Diagram**

**Figure 34. Assess Waveforms & Calculate Standard Range Corrector Subprocesses**

The normal sequence of processes (indicated by double headed arrows) is: check the waveform for saturation (W\_Ck4Sat); define the begin and end of the noise and signal (W\_DefnNsSigBE); characterize the transmitted pulse (W\_CharTrPulse); calculate the centroid, maximum, area, and asymmetry of the waveform (W\_CalcCtMxArAs); and then calculate the standard range corrector (W\_CalcStdRCorr). Each of these processes will send quality assurance (QA) information to W\_CreAsQASstats which will return QA information to W\_Assess. W\_Assess will not be called for reprocessing.

# DRAFT



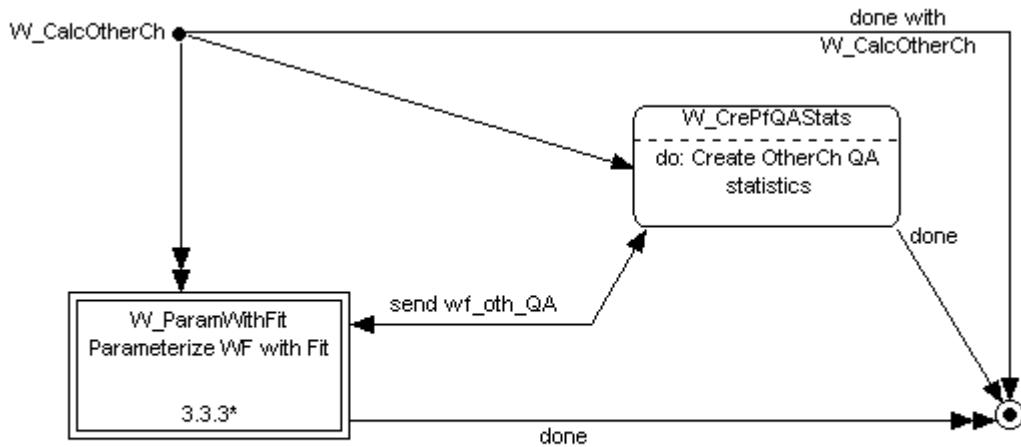
## Determine Geolocation and Surface Type State Diagram

**Figure 35. Determine Geolocation and Surface Type Subprocesses**

The normal sequence of processes (indicated by double headed arrows) is: interpolate the orbit (C\_IntrpPOD); calculate elevation and geolocation (C\_CalcElvLoc); and then determine the surface type (W\_DetSurfType). Quality assurance (QA) information for processes C\_IntrpPOD and C\_CalcElvLoc will be generated by W\_DetGeoSurTyp and sent to W\_CreGsQAStats. Process W\_DetSurfType will send quality assurance (QA) information to W\_CreGsQAStats which will return QA information to W\_DetGeoSurTyp.

During reprocessing: if attitude data changes, C\_CalcElvLoc and W\_DetSurfType will be called; if orbit data changes, C\_IntrpPOD, C\_CalcElvLoc, and W\_DetSurfType will be called; if std\_range\_corr changes, C\_CalcElvLoc and W\_DetSurfType will be called. W\_CreGsQAStats will not be called during reprocessing.

# DRAFT



**Calculate Other WF Characteristics State Diagram**

**Figure 36. Calculate Other Waveform Characteristics Subprocesses**

The normal sequence of processes (indicated by double headed arrows) is: parameterize the waveform (W\_ParamWithFit). This process sends quality assurance (QA) information to W\_CrePfQAStats which will return QA information to W\_CalcOtherCh.

During reprocessing, if any surface-specific algorithms have changed, and/or the surface type grid has changed, and/or the standard waveform correction has changed, then W\_ParamWithFit will be called to reprocess data with those surface types. W\_CrePfQAStats will not be called during reprocessing.

**Table 4. Reprocessing Decision Table**

If these variables change:	1	2	3	4	5	6
land algorithm	x					
non-land algorithm		x				
orbit (POD)			x			
attitude (PAD)				x		
surface type grid					x	
standard waveform correction					x	
Then these actions are taken:						
3.2.2 Interpolate Orbit (C_IntrpPOD)			x			
3.2.3 Calculate Elevation & Geolocation (C_CalcElvLoc)			x	x		x
3.2.4 Determine Surface Type (W_DetSurfType)			x	x		x
3.3.3 Param WF with Fit for Land (W_ParamWithFit)	x	x			?	?

? - do if the surface type changes or if the standard waveform correction changes

# DRAFT

## 11.4 Level 1B and 2 Atmosphere

**Table 5. Level 1B and 2 Atmosphere Computations Reprocessing Decision Table**

Reprocessing Scenario Number	1	1	2	2	2	1	2	2	2	3	5	4	6	7	8	9	10	11	12	13	
	Module X																				
	Input Files				Processes																
<b>Module Y</b>																					
A_intrp_geoloc	x	x																			?
A_interp_met	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_mbscs	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_cal_cofs	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_ir_bscs	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_g_bscs	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_bs_qa_stats	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_avg_bscs	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_cld_lays	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_pbl_lay	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_aer_lays	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_lh_qa_stats	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_aer_opt_prop	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_cld_opt_prop	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_op_qa_stats	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
A_qa_stats	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
GLA07 Backscatter Cross Section Profiles	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
GLA08 PBL/Aerosol Layer Heights	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
GLA09 Cloud Layer Heights	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
GLA10 Cloud and Aerosol Cross Section Profiles	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	
GLA11 Cloud and Aerosol Optical Depths	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	

The accompanying reprocessing decision table illustrates the possible scenarios for data processing and reprocessing. Columns (X) are divided into input files and processes, which if modified, require the execution of processes and the recreation of atmosphere products in rows (Y). The table reads, “if module X changes, then reprocess module Y”, or conversely, “module Y needs to be reprocessed if module X changes”. The items that need to be reprocessed are denoted with an “x”. The reprocessing scenario number refers to a sequence of processes that are run under certain conditions. For example, if process A\_avg\_bscs experiences an algorithm change (reprocessing scenario 8), then processes A\_interp\_met, A\_avg\_bscs, and subsequent processes, except for A\_pbl\_lay and A\_aer\_lays, are reprocessed, recreating parameters for output products GLA08 – 11. Columns with identical reprocessing scenario numbers indicate that for those conditions the same sequence is run. For example, reprocessing scenario 1 (all processes are rerun) is triggered if input POD data changes, if input off-nadir data changes, or if the algorithm in the geolocation process A\_intrp\_geoloc changes.

Note that small changes in precision orbit determination (POD), off-nadir data, meteorological (met) data, or standard atmosphere (std atm) data do not affect atmosphere reprocessing because these data do not need to be precise for these computations. However, if any of these data are corrupt then the appropriate reprocessing scenario needs to be followed. Question marks denote uncertainty as to whether data will be reprocessed if QA algorithms change. Asterisks denote processes that have a higher probability of having their algorithms changed and thus a higher probability of requiring reprocessing. These processes include those which calculate the calibration coefficients (A\_cal\_cofs), create the attenuated backscatter profiles (A\_ir\_bscs, A\_g\_bscs), determine the cloud and aerosol layers (A\_cld\_lays, A\_pbl\_lay, A\_aer\_lays), and compute the cloud and aerosol optical properties (A\_cld\_opt\_prop, A\_aer\_opt\_prop).

Two of the processes (A\_mbscs and A\_cal\_cofs) have been divided into two portions. This is because the process which calculates the 1064 nm backscatter cross section profiles (A\_ir\_bscs) may or may not use the 1064 nm calibration coefficient calculated in the process A\_cal\_cofs. If the coefficient is unreliable, a lab-measured constant will be used instead. If a constant is used instead, then changes to the calculated coefficient will not affect subsequent processing. Therefore, reprocessing scenarios for a coefficient that is not used in further processing (scenarios 3 and 4) are separated out from the scenarios where the calculated coefficient is used for further processing (scenarios 2 and 5).

# DRAFT

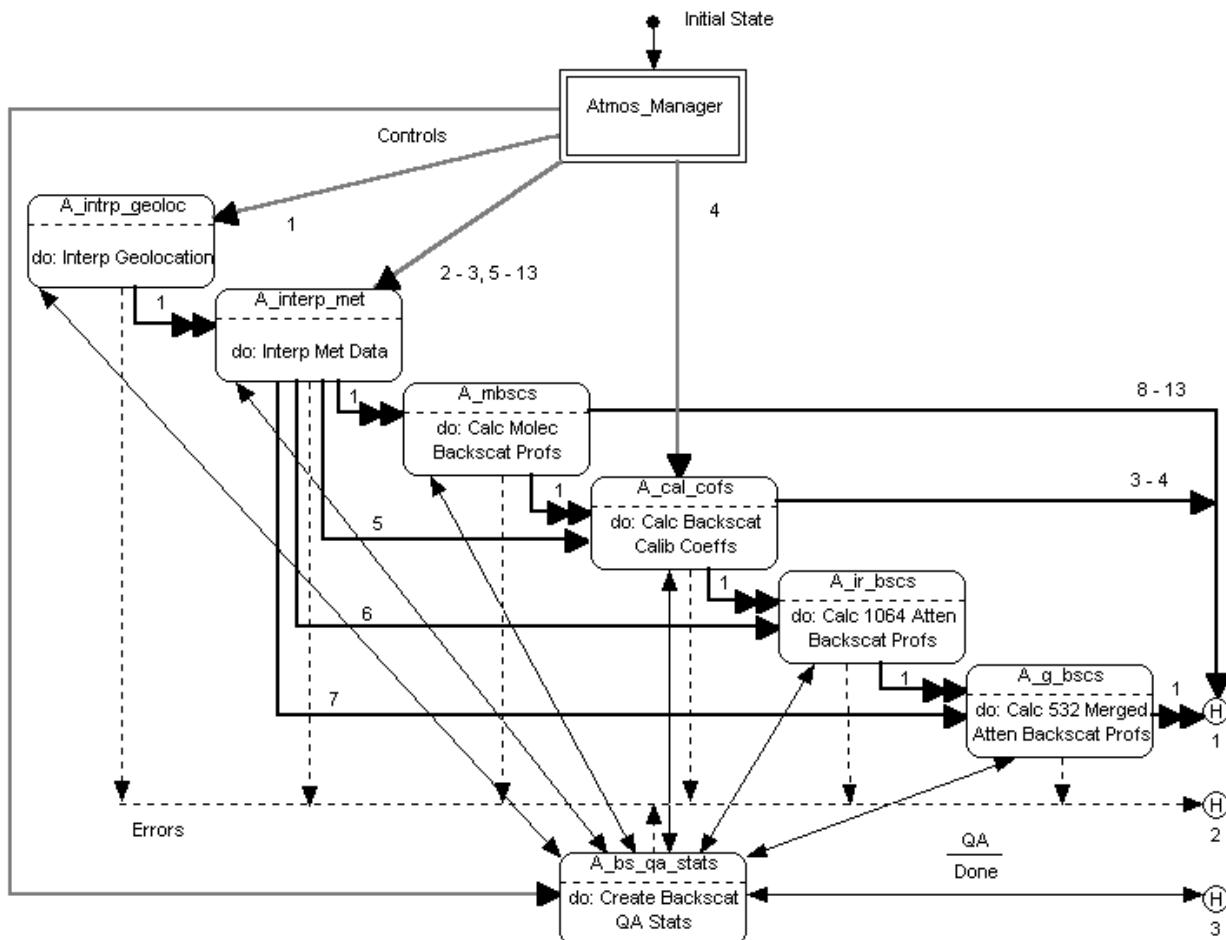
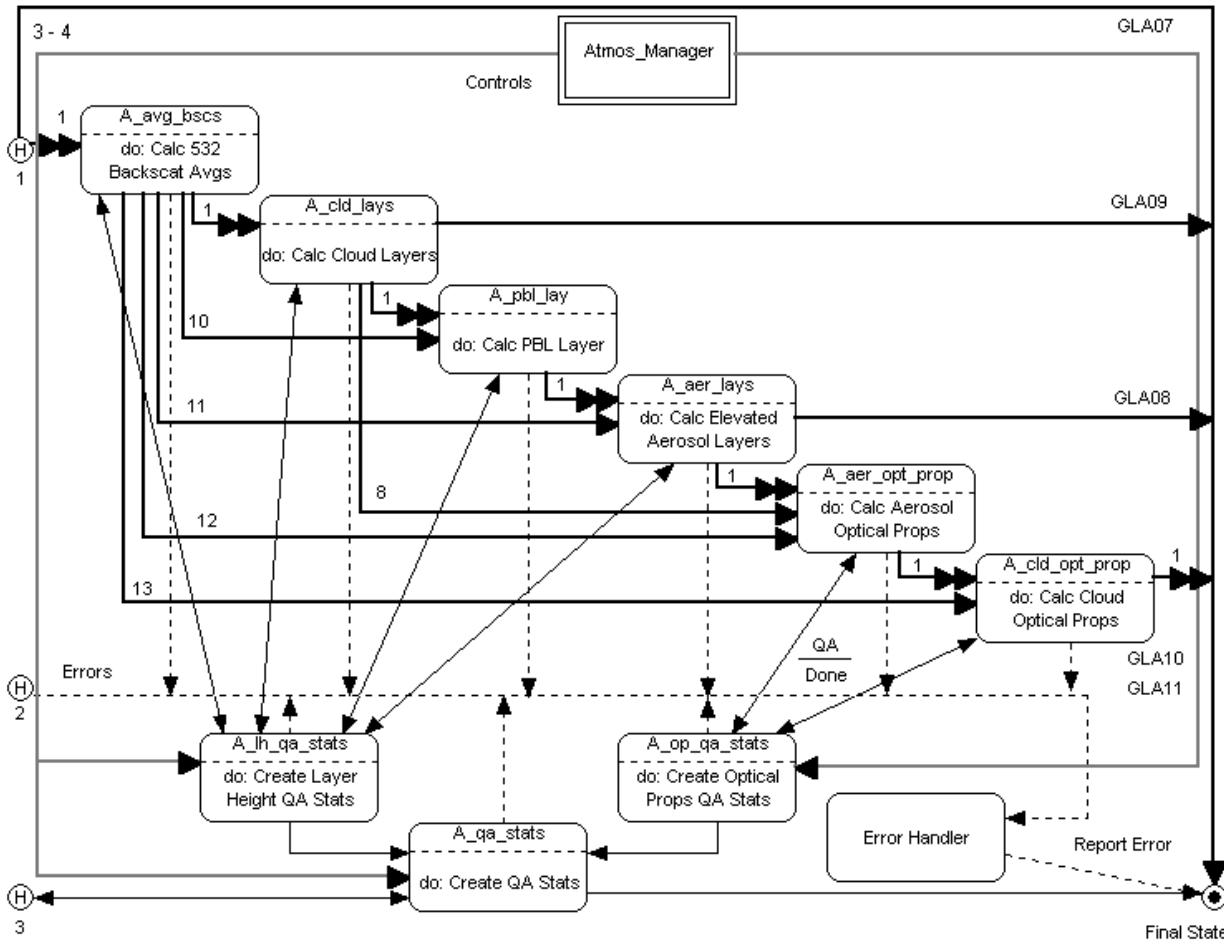


Figure 37. Level 1B and 2 Atmosphere Computations State Transition Diagrams

# DRAFT



**Figure 38.**

The accompanying state transition diagrams illustrate the atmosphere computations processing and reprocessing states. The first figure depicts processes A\_intrp\_geoloc through A\_bs\_qa\_stats and the second figure depicts processes A\_avg\_bsbs through A\_qa\_stats. These figures should be combined to represent all of the states in the entire atmosphere computations subsystem.

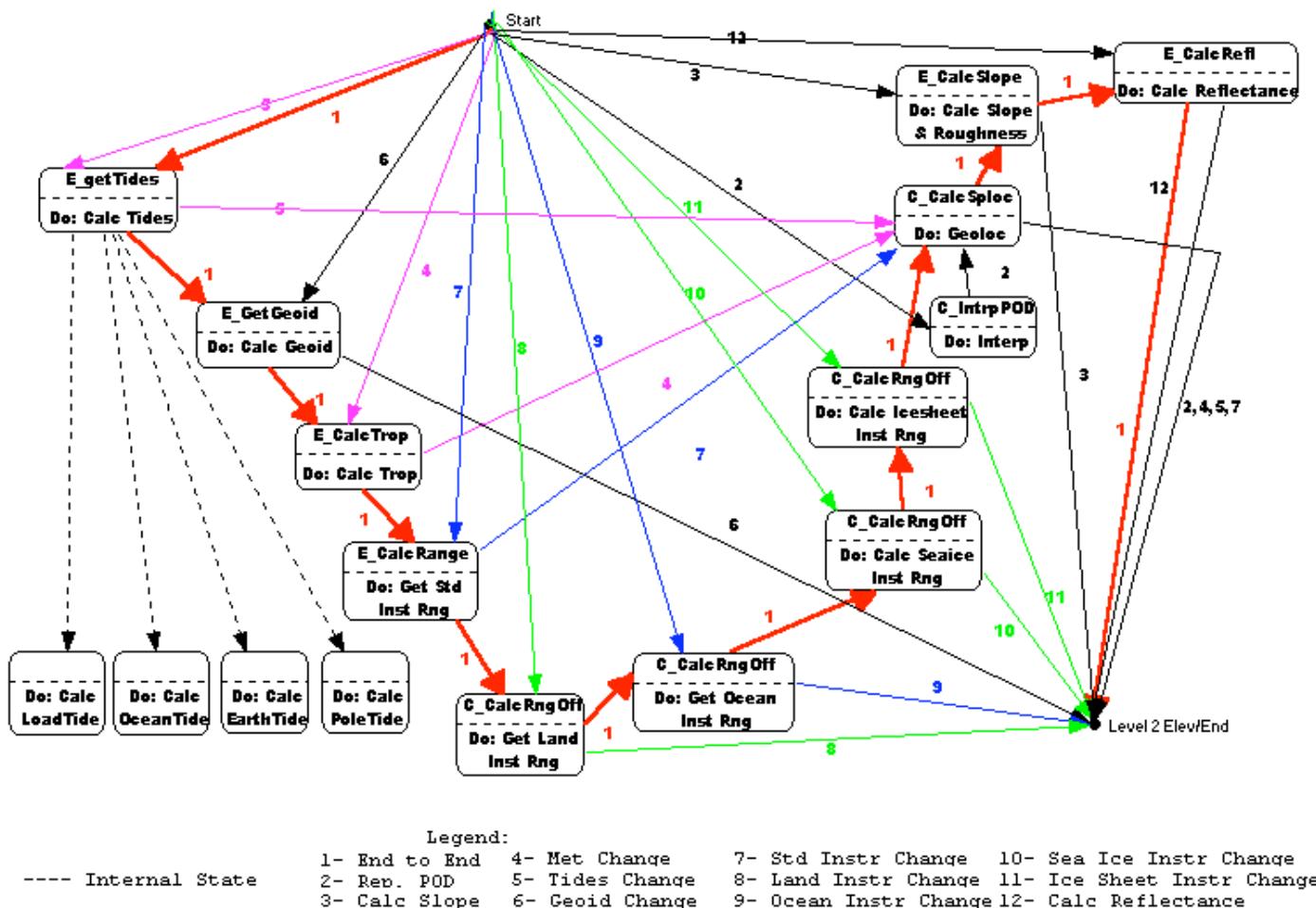
The first diagram shows the initial state (start of processing) leading into the Level 1B and 2 atmosphere computations manager (Atmos\_Manager). From the manager, controls (represented by arrows from the manager to several processes) trigger each of the reprocessing scenarios. Processes that do not have control arrows leading directly to them cannot be called by themselves in a reprocessing scenario. This occurs in instances when processes need input data that are not saved, therefore that data must be regenerated in a prior process for that process to use. It is shown in the diagrams that most of the scenarios start with process A\_interp\_met. This is because the interpolated met data are used in several processes, yet they are not saved for reprocessing access and therefore must be regenerated at the start of each reprocessing scenario. Scenarios where the POD or off-nadir data need to be reprocessed start with process A\_interp\_pod. One scenario starts with the process A\_cal\_cofs since all the input data it needs can be retrieved from available products.

Double headed arrows represent quality assurance (QA) data going from each process to a “QA Statistics” (qa\_stats) process and “done” signals which are transmitted back when the calls are complete. Dotted lines represent errors that are passed from each process to the error handler for evaluation of severity. Errors that can occur in most of the processes include data out-of-bounds, incomplete buffer, and time gap errors. If data are found to be outside a range of acceptable values (out-of-bounds), then processing may be continued without those data points or processing may stop if the extent of unacceptable values is large. For example, bad LIDAR data in one record would raise a flag, but would not halt processing, while a series of bad POD values might. Since averages are taken over many records in several of the processes, incomplete buffers due to bad data and time gaps will create errors. However, in most cases processing will continue, with a flag raised, for an incomplete buffer.

# DRAFT

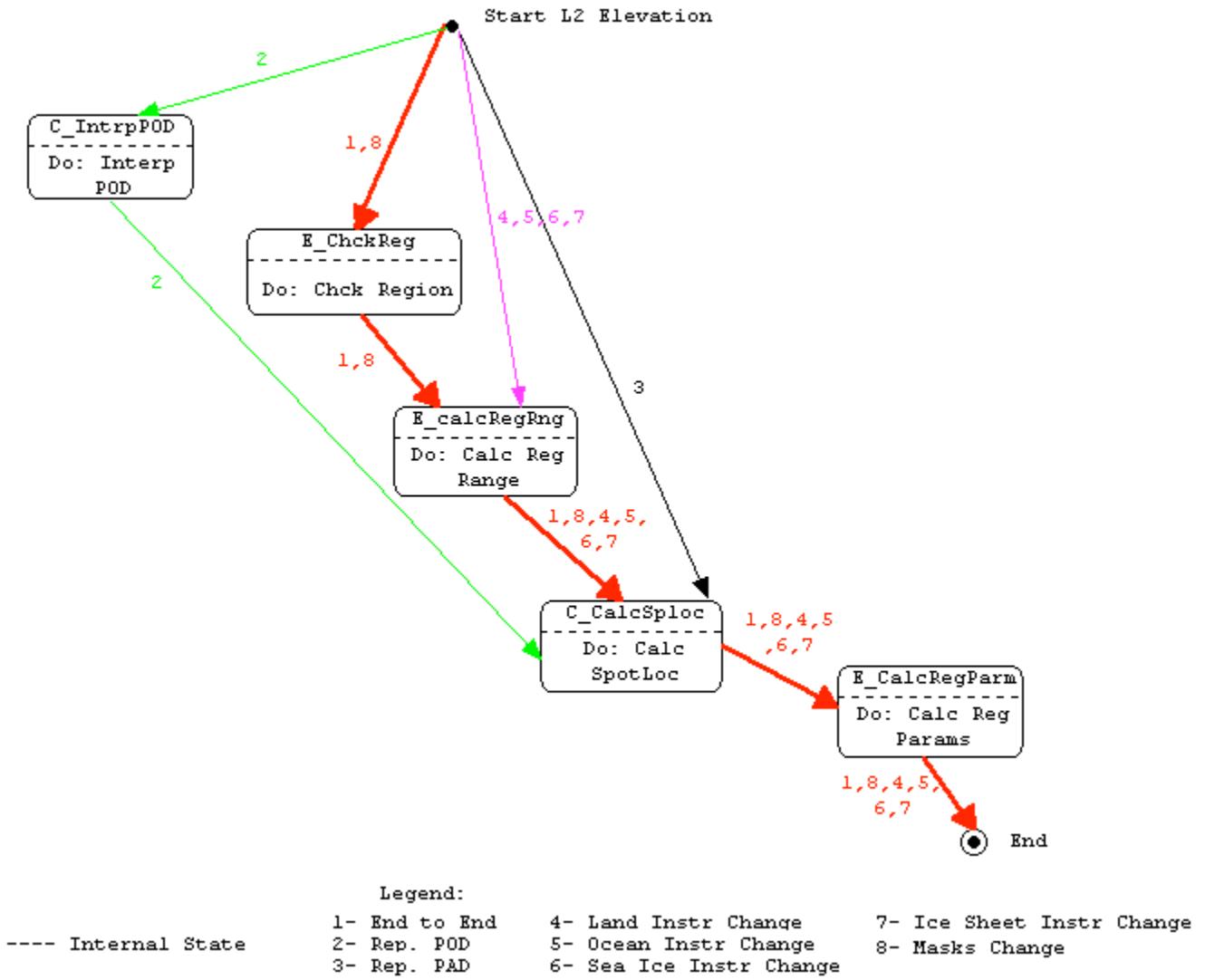
Lines with double arrows (marked with the number 1) indicate the main processing sequence while numbered lines with single arrows represent reprocessing scenarios. As shown in the second diagram, all of the processing scenarios eventually end at the final state. Lines marked GLA07, GLA08, and GLA09 indicate where the processing parameters for these products are generated. Parameters for GLA10 and GLA11 are created at the end of the main processing sequence, after process A\_cld\_opt\_prop. In production processing, processes A\_intrp\_geoloc through A\_cld\_opt\_prop are triggered in the order shown on the diagrams from left to right. In reprocessing, the processes are still executed in that order, however, the initial process may be different and processes may be skipped. In the diagrams, the scenario numbers match those on the reprocessing decision table. In each scenario, the main sequence (1) is followed, unless the appropriate numbered alternative is present. For example, if process A\_aer\_lays needs to be reprocessed (scenario 11), the lines numbered 11 indicate that process A\_interp\_met is first triggered, followed by processes A\_mbsscs, A\_avg\_bscs, A\_aer\_lays, A\_aer\_opt\_prop, and A\_cld\_opt\_prop in that order. As another example, If process A\_interp\_met needs to be reprocessed (scenario 2), then the main processing sequence starting at process A\_interp\_met is followed, since no lines numbered 2 are present.

## 11.5 Level 1B and 2 Elevation



**Figure 39.**

# DRAFT



**Figure 40.**

The scenarios reflect changes in Level 1B elevation. If the results are only needed for GLA06, we stop at the end of the actions listed under Level 1B elevation. If the results are required for GLA12,13,14,15 we continue till the end of Level 2 elevation.

# DRAFT

**Table 6. Reprocessing Scenario Stages For Level 1B Elevations**

<u>Variables</u>					<u>State</u>								
POD	Yes	No	No	No	No	No	No	No	No	No	No	No	No
PAD	No	Yes	No	No	No	No	No	No	No	No	No	No	No
Met Data	No	No	Yes	No	No	No	No	No	No	No	No	No	No
Std Instr Range	No	No	No	Yes	No	No	No	No	No	No	No	No	No
Land Instr Range	No	No	No	No	Yes	No							
Ocean Instr Range	No	No	No	No	No	Yes	No						
Sea Ice Instr Range	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Ice Sheet Instr Range	No	No	No	No	No	No	No	Yes	No	No	No	No	No
Load Tide Model	No	No	No	No	No	No	No	No	Yes	No	No	No	No
Ocean Tide Model	No	No	No	No	No	No	No	No	No	Yes	No	No	No
Pole Tide Model	No	No	No	No	No	No	No	No	No	No	Yes	No	No
Earth Tide Model	No	No	No	No	No	No	No	No	No	No	No	Yes	No
Geoid Model	No	No	No	No	No	No	No	No	No	No	No	No	Yes
<b>Action</b>													
<b>Level 1B Elevation</b>													
Load Tide Corr	No	No	No	No	No	No	No	No	Yes	No	No	No	No
Ocean Tide Corr	No	No	No	No	No	No	No	No	No	Yes	No	No	No
Pole Tide Corr	No	No	No	No	No	No	No	No	No	No	Yes	No	No
Earth Tide Corr	No	No	No	No	No	No	No	No	No	No	No	Yes	No
Geoid Hgt	No	No	No	No	No	No	No	No	No	No	No	No	Yes
Trop Corr	No	No	Yes	No	No	No	No	No	No	No	No	No	No
Std Instr Range	No	No	No	Yes	No	No	No	No	No	No	No	No	No
Land Instr Range	No	No	No	No	Yes	No							
Ocean Instr Range	No	No	No	No	No	Yes	No						
Sea Ice Range	No	No	No	No	No	No	Yes	No	No	No	No	No	No
Ice Sheet Range	No	No	No	No	No	No	No	Yes	No	No	No	No	No
Interp POD	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Calc Std Elev & Spot	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	No
Calc Quality Flag	Yes?	Yes?	No	No	No	No	No	No	No	No	No	No	No
Calc Slope & Roughness	No	No	No	No	No	No	No	No	No	No	No	No	No
Calc Reflectance	No	No	No	No	No	No	No	No	No	No	No	No	No
Create L1B Quality Stats	No	No	No	No	No	No	No	No	No	No	No	No	No

# DRAFT

<b><u>Level 2 Elevation</u></b>												
Check region	Yes	No										
Calc Region Sp Range	Yes	No										
Calc SpotLoc	Yes	No										

NOTE: If there are a combination of changes the collective action will be the sum of each individual action. The order of processing is in the order shown in the table.

Scenarios for changes in variables in Level 2 Elevation only.

**Table 7. Reprocessing Scenario Stages For Level 2 Elevations**

<b><u>Variables</u></b>									
					<b><u>State</u></b>				
POD	Yes	No	No	No	No	No	No	No	No
PAD	No	Yes	No	No	No	No	No	No	No
Land Instr Range	No	No	Yes	No	No	No	No	No	No
Ocean Instr Range	No	No	No	Yes	No	No	No	No	No
Sea Ice Instr Range	No	No	No	No	Yes	No	No	No	No
Ice Sheet Instr Range	No	No	No	No	No	Yes	No	No	No
Land mask	No	No	No	No	No	No	Yes	No	No
Ocean mask	No	No	No	No	No	No	No	Yes	No
Sea Ice mask	No	No	No	No	No	No	No	No	Yes
Ice Sheet Mask	No	No	No	No	No	No	No	No	Yes
<b><u>Action</u></b>									
<b><u>Level 2 Elevation</u></b>									
Interp POD	Yes	No	No	No	No	No	No	No	No
Check region	No	No	No	No	No	No	Yes	Yes	Yes
Calc Region Sp Range	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Calc SpotLoc	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NOTE: If there are a combination of changes the collective action will be the sum of each individual action. The order of processing is in the order shown in the table.

Figures 16 and 17 show the various processing/reprocessing scenarios possible for Level 1B and Level 2 Elevations. The End-to-End state signifies a normal processing scenario. In Figure 16, the normal end-to-end state is as follows: first calculate the Tide corrections (E\_getTides), then the geoid height (E\_GetGeoid), the troposphere corrections (E\_CalcTrop), the standard instrument range correction (E\_CalcRange), the land instrument range correction offset (C\_CalcRngOff), the ocean instrument range correction offset (C\_CalcRngOff), the sea ice instrument range correction offset (C\_CalcRngOff), the ice sheet instrument range correction offset (C\_CalcRngOff), perform the geolocation (C\_CalcSploc), calculate the slope and roughness (E\_CalcSlope), and finally calculate the reflectance (E\_CalcRefl). The Tide corrections process will calculate the individual tides (i.e. ocean tide, load tide, pole tide, and earth tide).

In the case of the Level 2 elevation (Figure 16), an end-to-end process flow comprises of: check to see which region the spot lies in (E\_ChkReg), and then depending on the regions defined and requested calculate the regional specific instrument range (E\_CalcRange), and spot locations and elevations (C\_CalcSploc). The region specific parameters will then be

# DRAFT

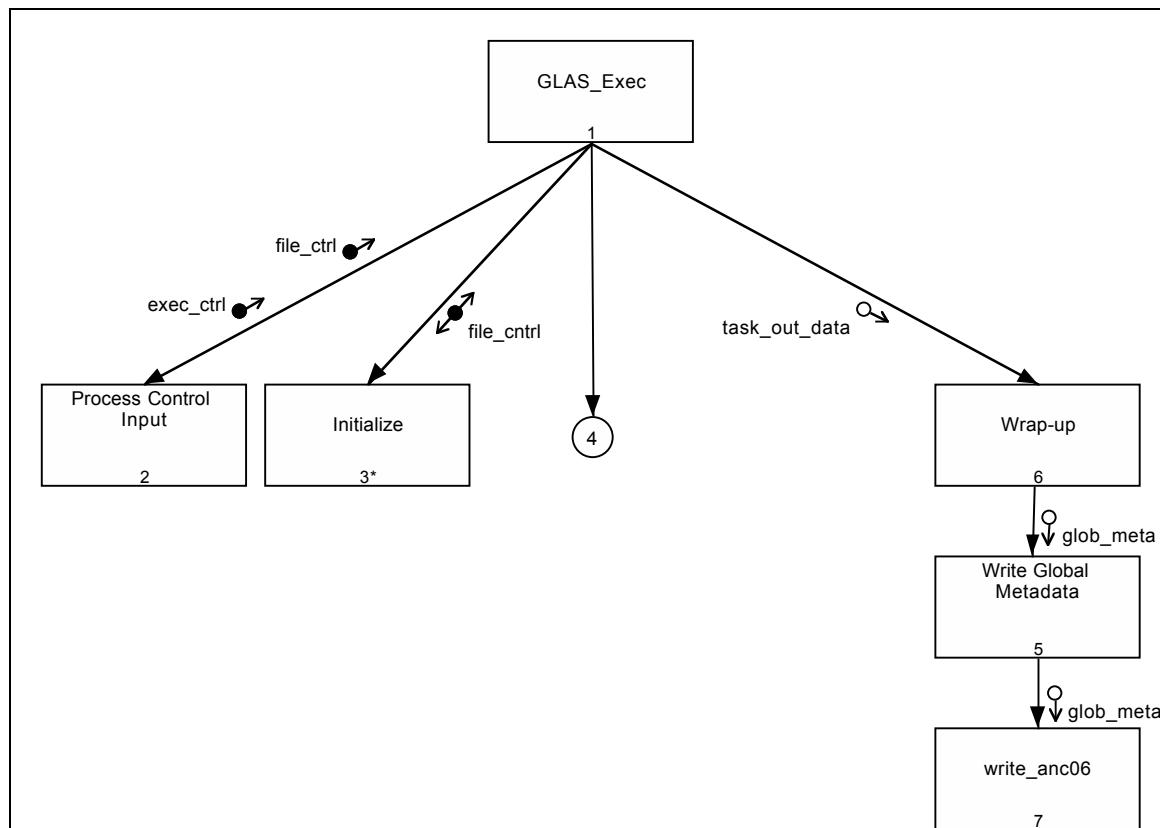
calculated (E\_CalcRegParm).

Tables 6 and 7 show he reprocessing scenarios that will be considered. Changes in the listed variables (designated as Yes - row wise), will require the processes, listed as Yes, to be executed. The order of processing is sequential (column-wise) as shown.

## 12 Structure Model(Structure Charts)

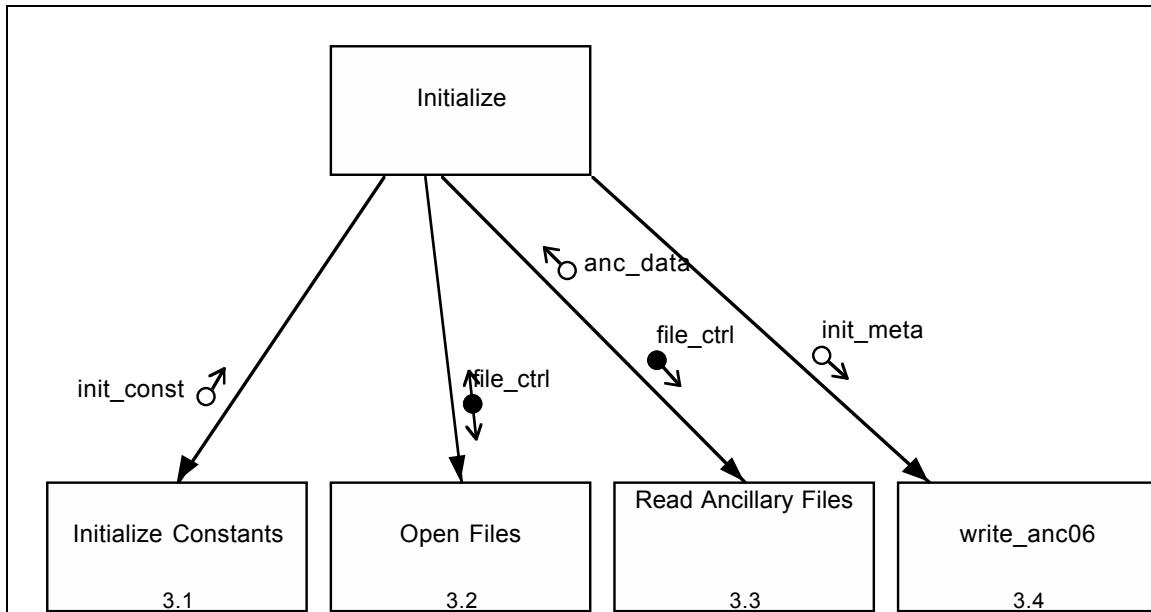
### 12.1 The I-SIPS Controller

#### 12.1.1 The Executor

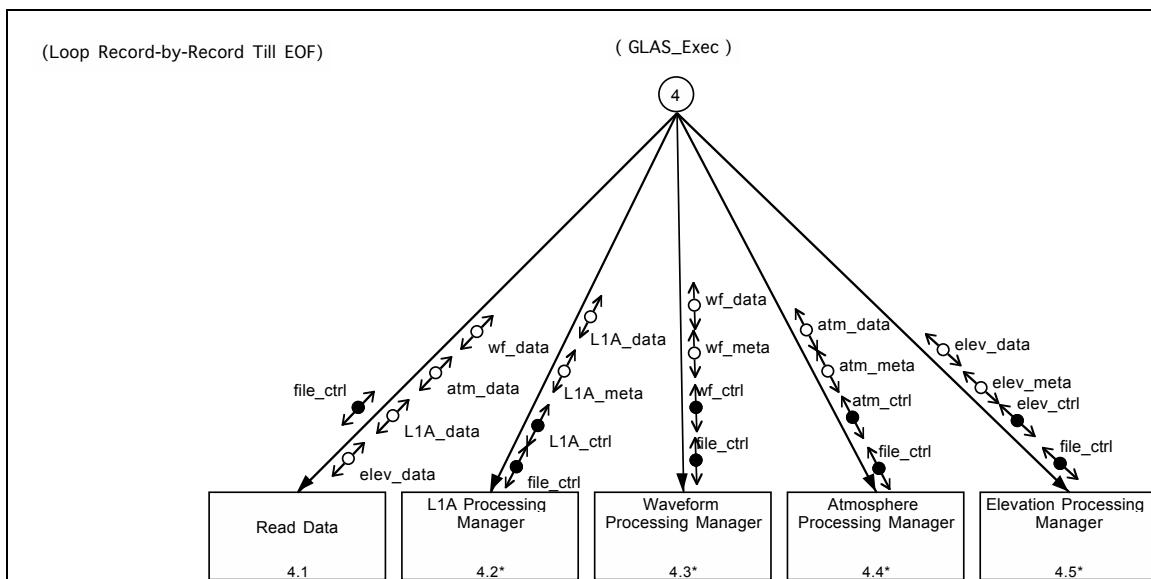


**Figure 41. GLAS Exec**

# DRAFT

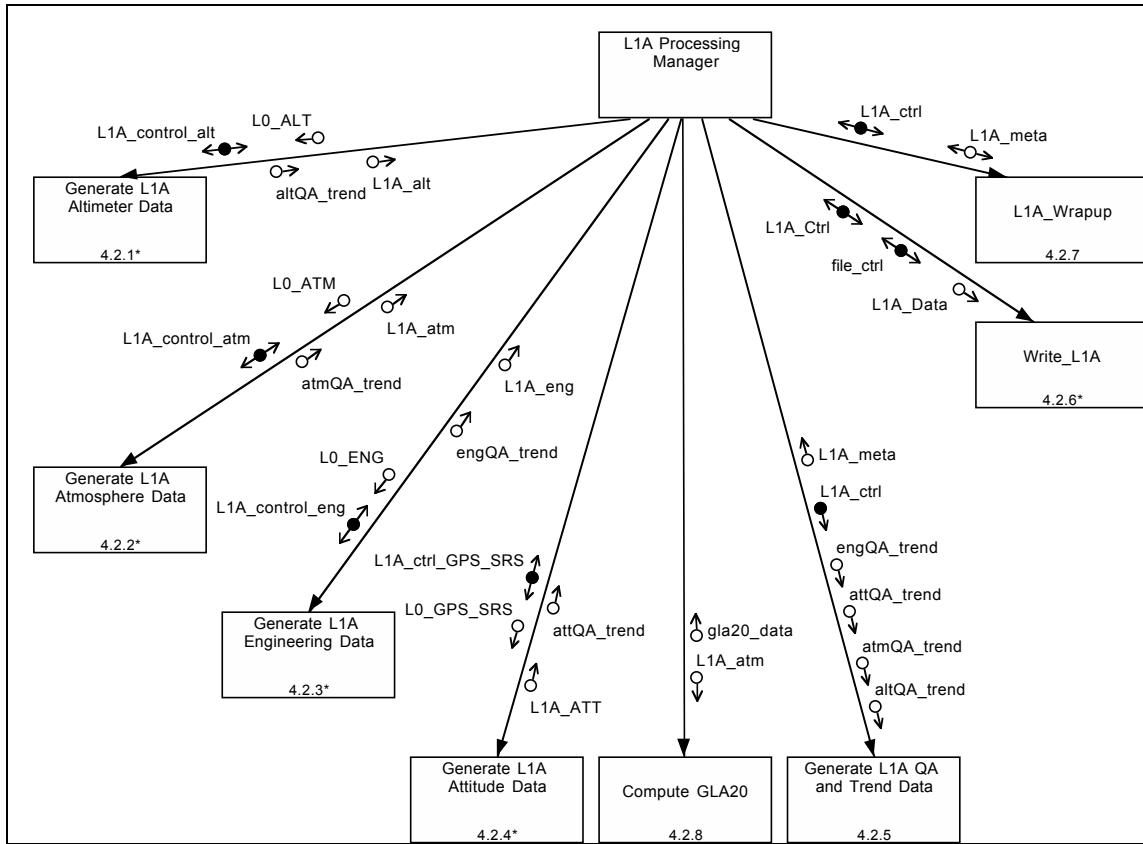


**Figure 42. Initialize**

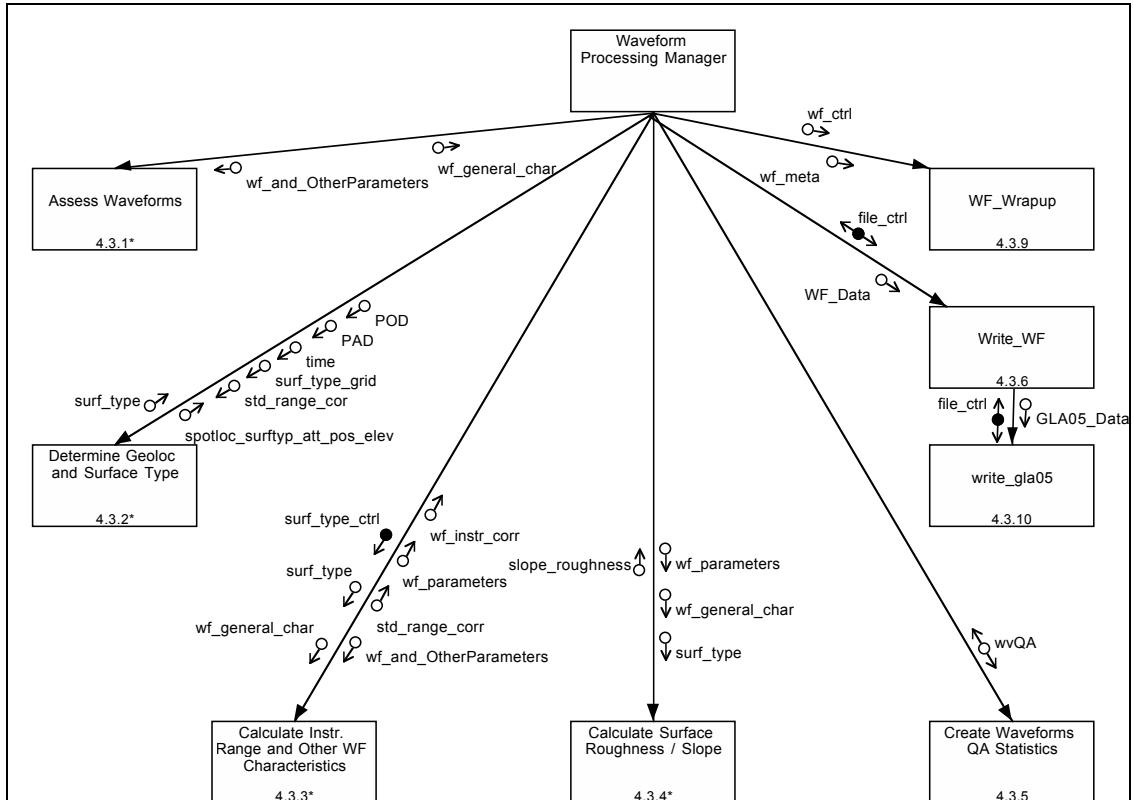


**Figure 43. Managers Stub (4)**

# DRAFT

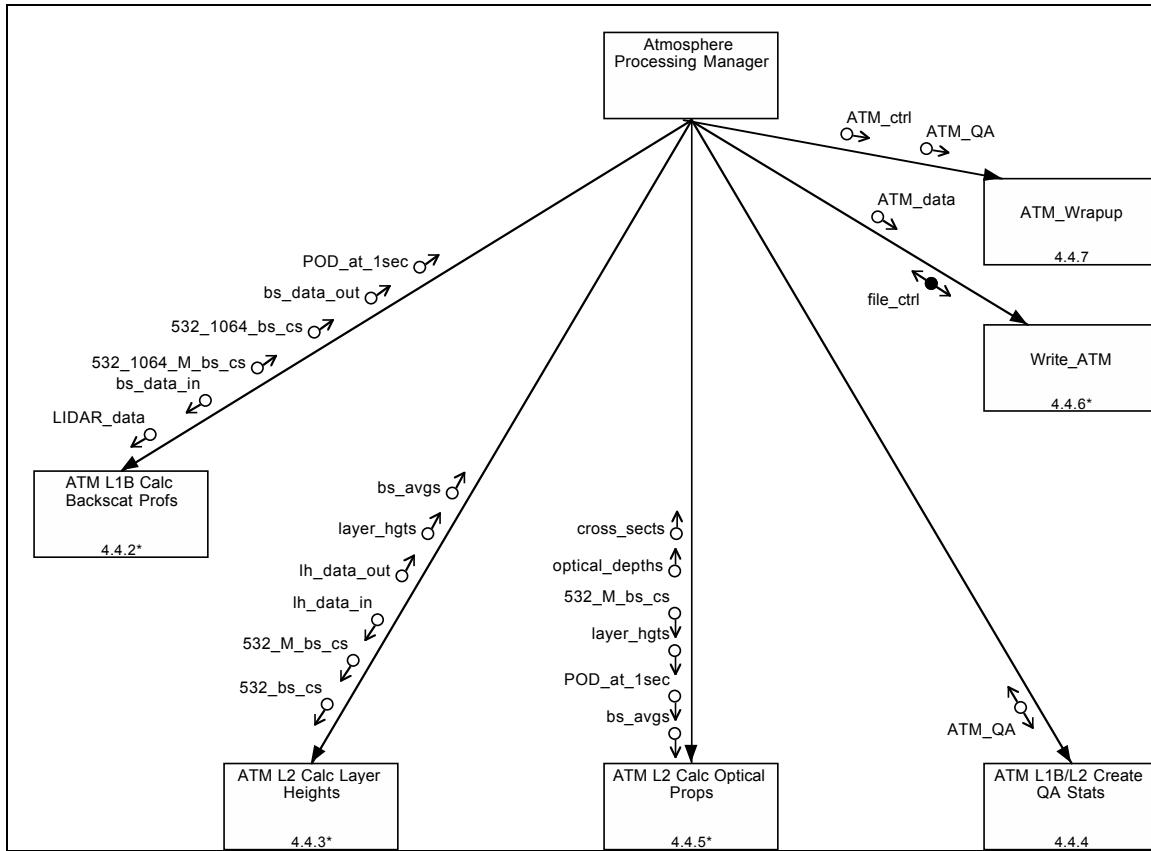


**Figure 44. L1A Processing Manager**

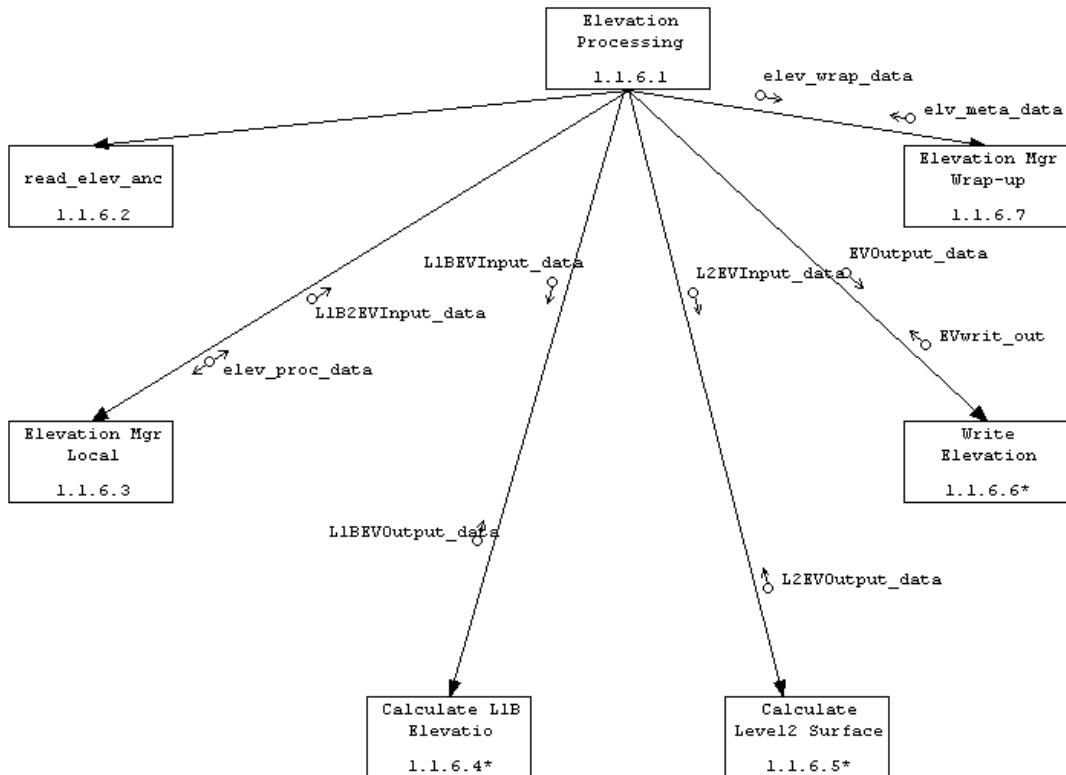


**Figure 45. Waveform Processing Manager**

# DRAFT



**Figure 46. Atmosphere Processing Manager**



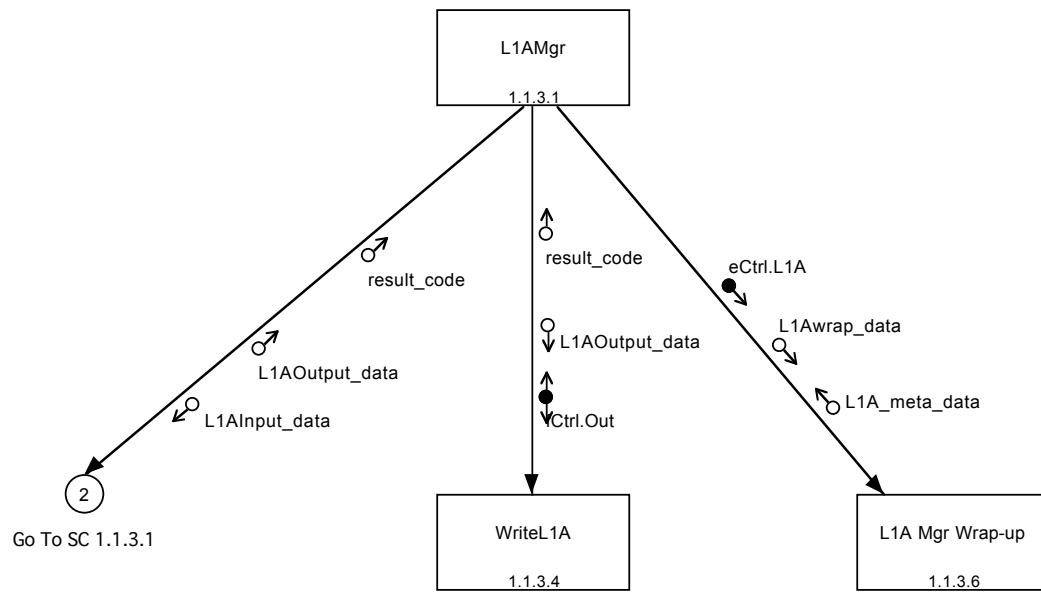
**Figure 47. Elevation Processing Manager**

## 12.1.2 Data Preparation, Formatting, Archiving

This section is to be filled in appropriately.

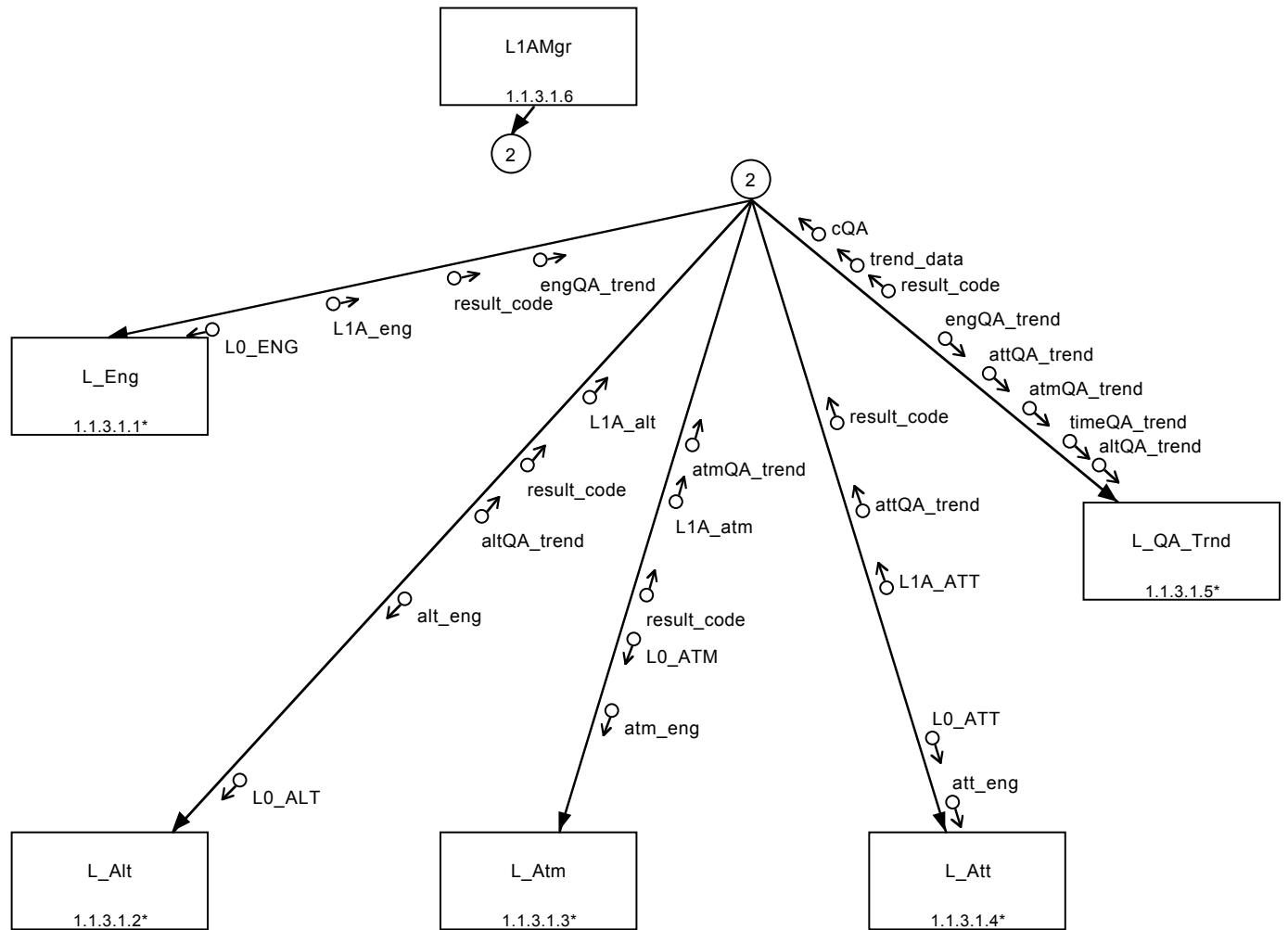
## 12.2 Level 1A Computations

IV. Structure Charts



**Figure 48.**

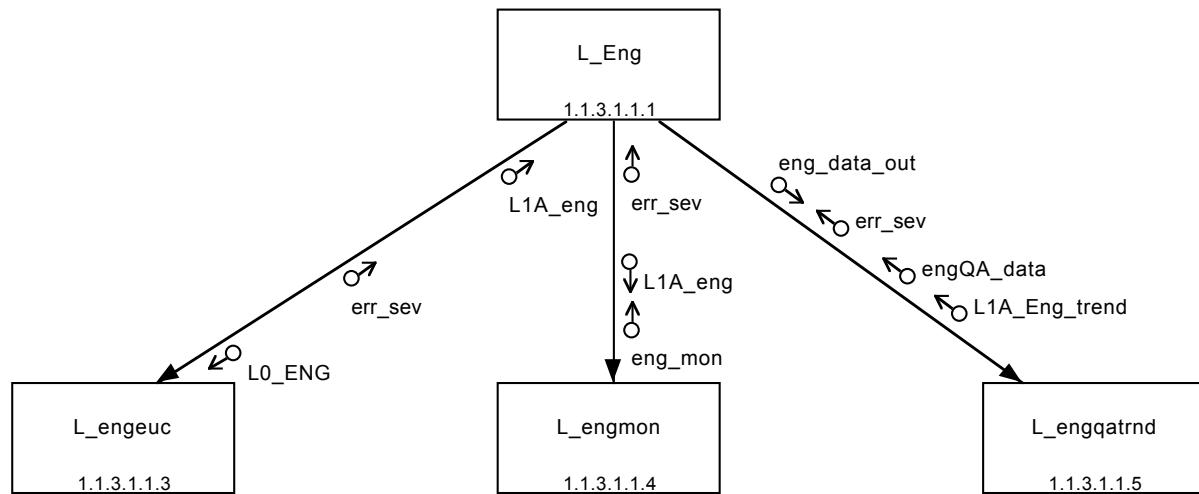
# DRAFT



Level 1A Computations Manager - Stub 2

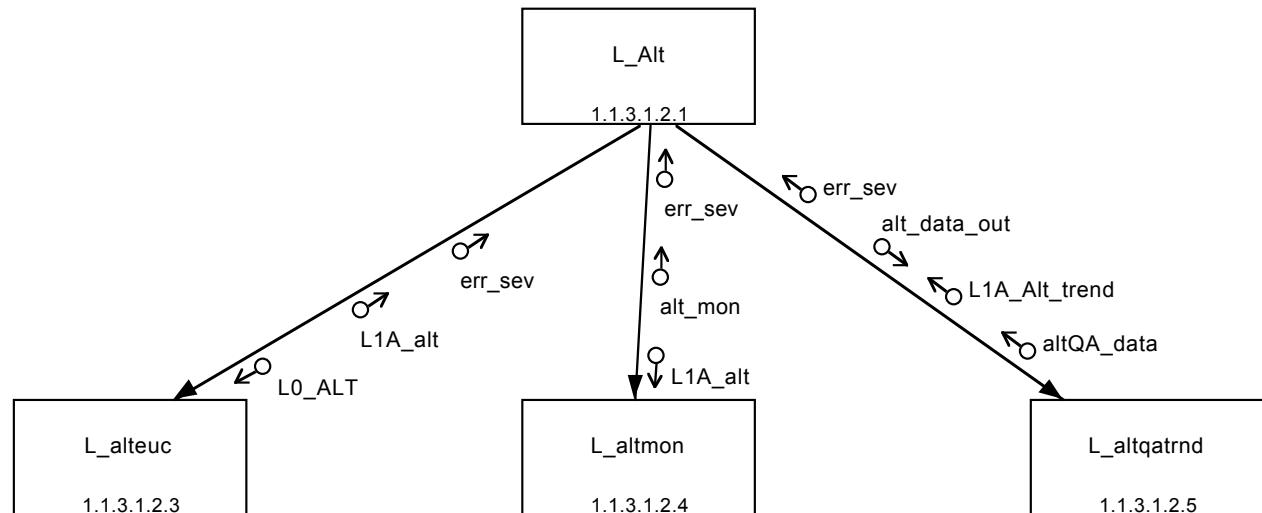
**Figure 49.**

# DRAFT



Generate Level 1A Engineering Data Product

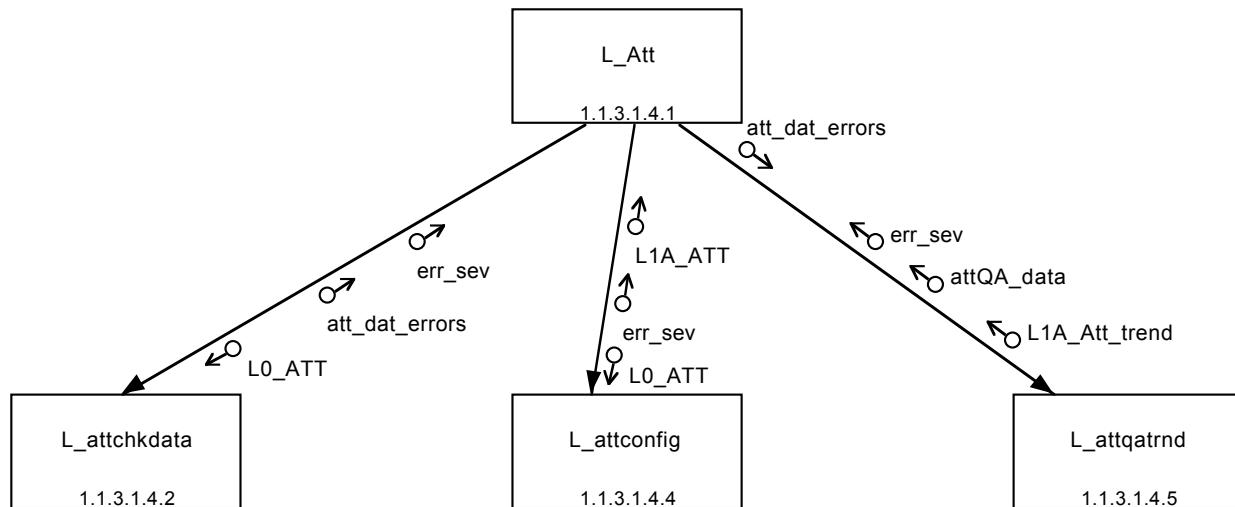
**Figure 50.**



Generate Level 1A Altimeter Data Product

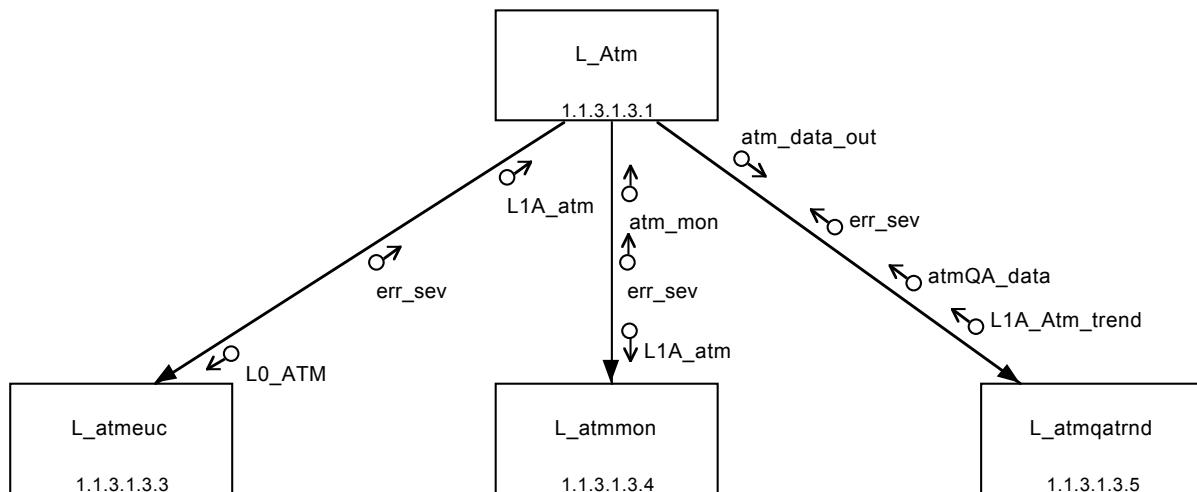
**Figure 51.**

# DRAFT



Generate Level 1A Attitude Data Product

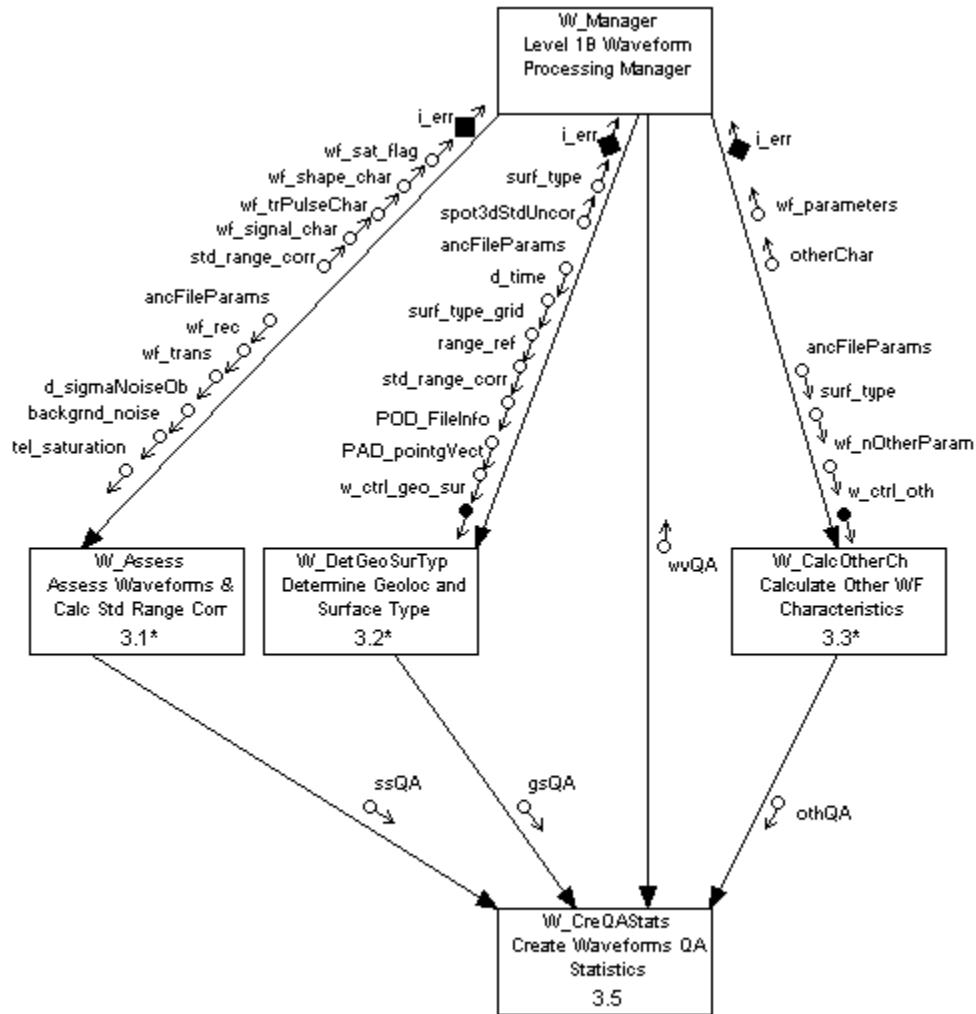
**Figure 52.**



Generate Level 1A Atmosphere Data Product

**Figure 53.**

## 12.3 Level 1B Waveforms



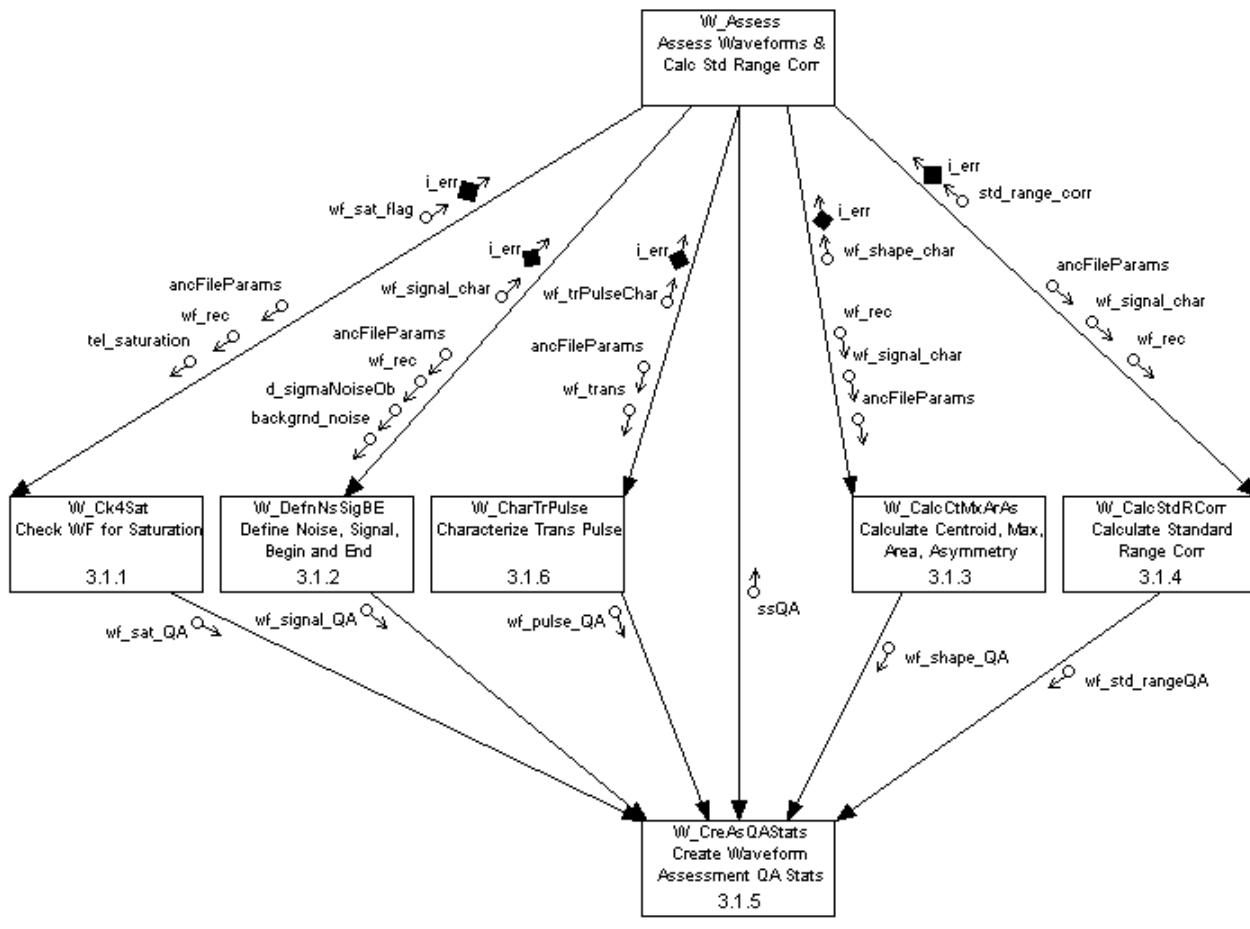
**Level 1B Waveforms Structure Chart**

**Figure 54. Structure Model (Structure Charts)**

During normal processing, the waveform processing manager (**W\_Manager**) calls the subprocesses **W\_Assess**, **W\_DetGeoSurTyp**, and **W\_CalcOtherCh**. Each of these subprocesses calls **W\_CreQASstats** with its QA data. When the subprocesses are finished, **W\_Manager** calls **W\_CreQASstats** to process the QA data and return waveform QA information for the current record.

For reprocessing: if either the orbital data or the attitude data has changed, **W\_DetGeoSurTyp** will be called; if any of the surface type algorithms have changed, **W\_CalcOtherCh** will be called. **W\_CreQASstats** will not be called during a reprocessing scenario.

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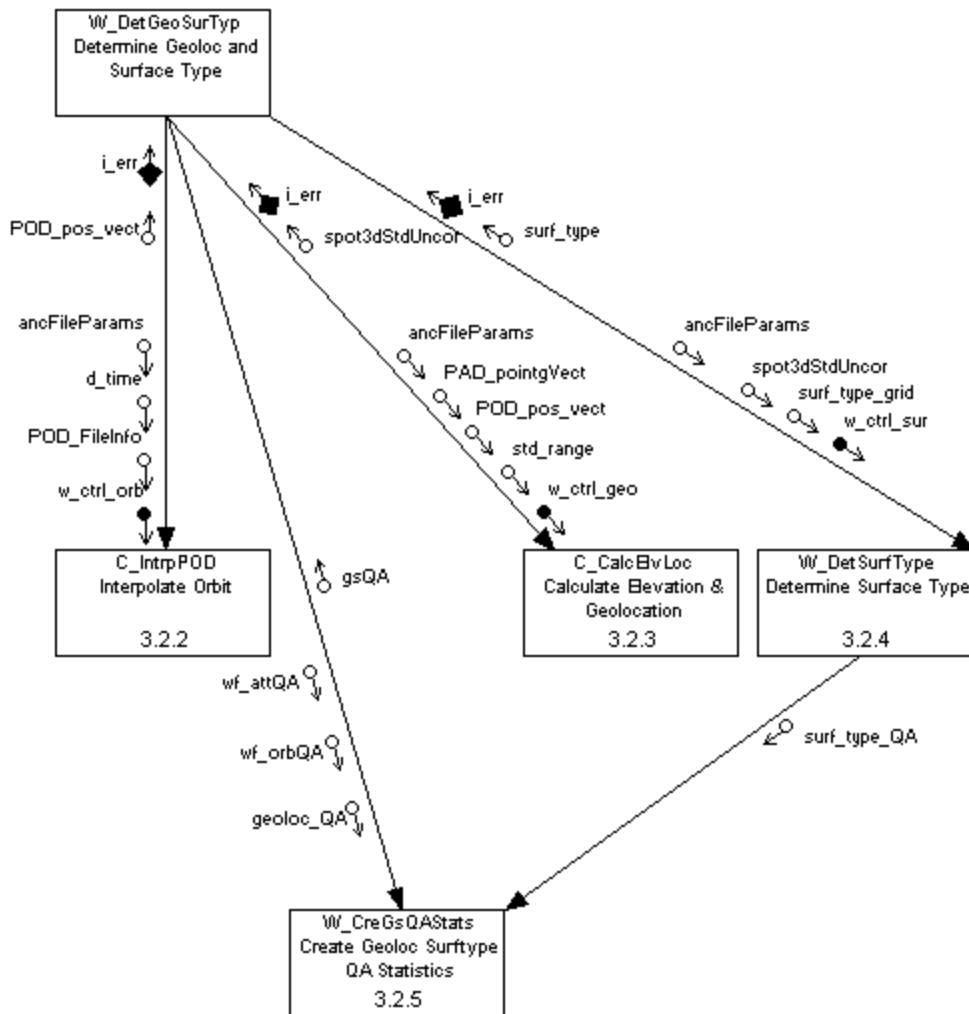


**Assess Waveforms & Calc Std Range Corr Structure Chart**

**Figure 55.**

During normal processing, W\_Assess calls the subprocesses W\_Ck4Sat, W\_DefnNsSigBE, W\_CharTrPulse, W\_CalcCtMxArAs, and W\_CalcStdRCorr. Each of these subprocesses calls W\_CreAsQASstats with its QA data. When the subprocesses are finished, W\_Assess calls W\_CreAsQASstats to process the QA data and return waveform QA information to W\_CreQASstats for the current record. W\_Assess will not be called for reprocessing.

# DRAFT



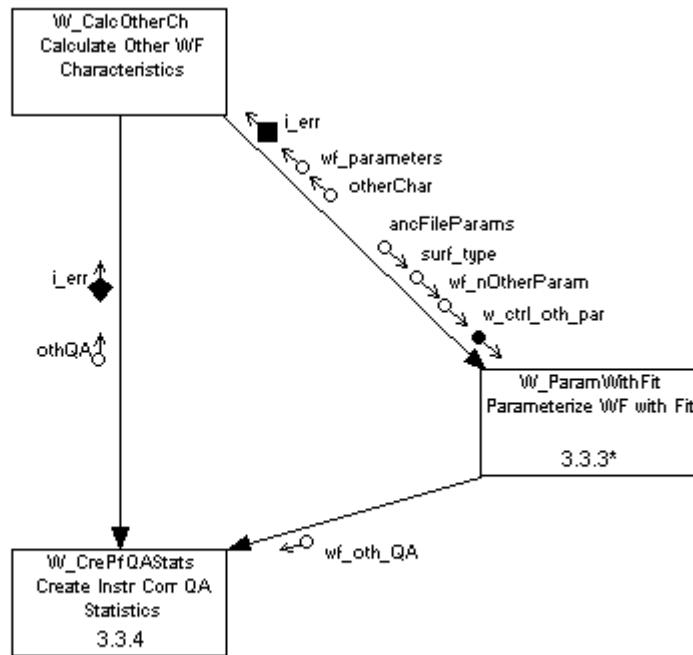
**Determine Geoloc and Surface Type Structure Chart**

**Figure 56.**

During normal processing, **W\_DetGeoSurTyp** calls the subprocesses **C\_IntrpPOD**, **C\_CalcElvLoc**, and **W\_DetSurfType**. **W\_DetGeoSurTyp** creates QA information for **C\_IntrpPOD** and **C\_CalcElvLoc**. **W\_DetSurfType** calls **W\_CreGSAStats** with its QA data. When the subprocesses are finished, **W\_DetGeoSurTyp** calls **W\_CreGSAStats** to process the QA data and return waveform QA information to **W\_CreGSAStats** for the current record.

During reprocessing: if attitude data changes, **C\_CalcElvLoc** and **W\_DetSurfType** will be called; if orbit data changes, **C\_IntrpPOD**, **C\_CalcElvLoc**, and **W\_DetSurfType** will be called; if *std\_range* changes, **C\_CalcElvLoc** and **W\_DetSurfType** will be called. **W\_CreGSAStats** will not be called during reprocessing.

# DRAFT



**Calculate Other WF Characteristics Structure Chart**

**Figure 57.**

During normal processing, `W_CalcOtherCh` calls the subprocess `W_ParamWithFit`. This subprocess calls `W_CrePfQAStats` with its QA data. Then `W_CalcOtherCh` calls `W_CrePfQAStats` to process the QA data and return waveform QA information to `W_CrePfQAStats` for the current record.

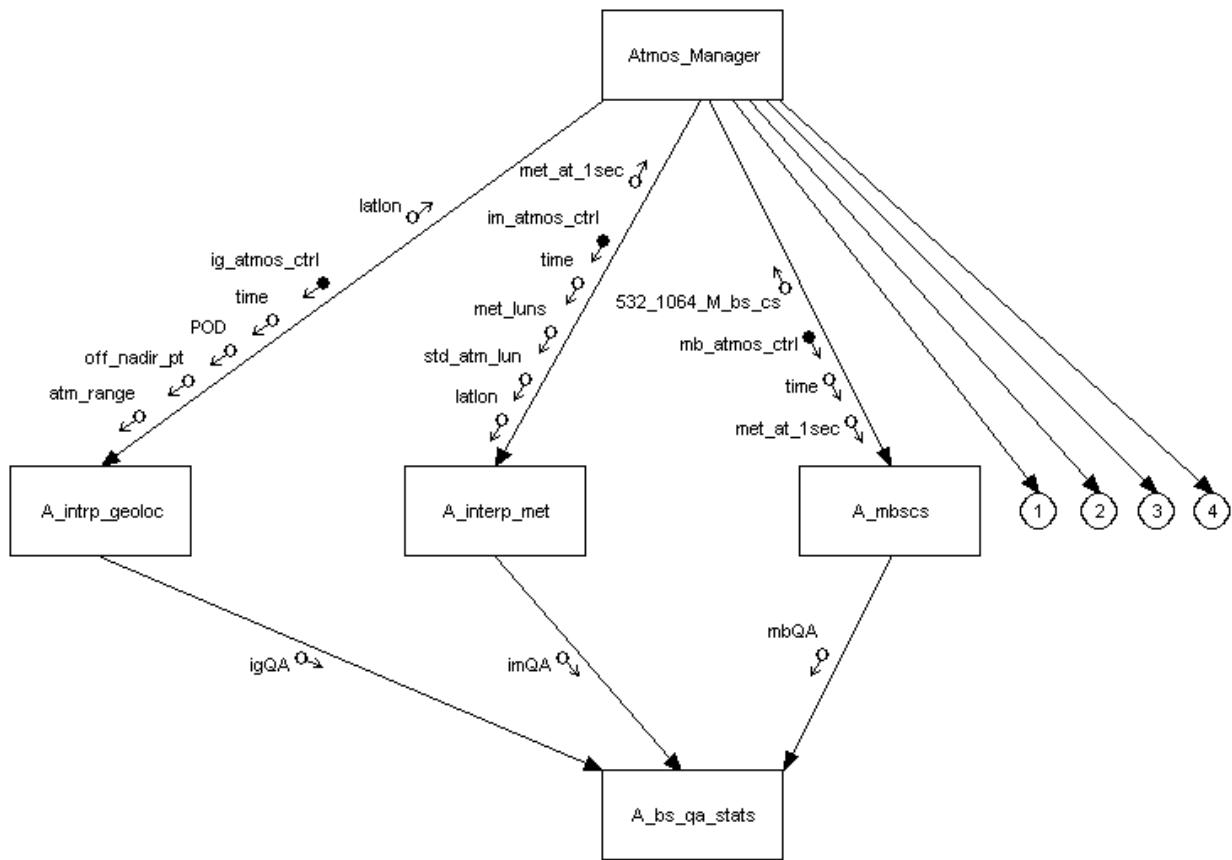
During reprocessing: if the surface specific algorithm, the surface type grid or `std_range_corr` changes `W_ParamWithFit` will be called. `W_CrePfQAStats` will not be called during reprocessing.

## 12.4 Level 1B and 2 Atmosphere

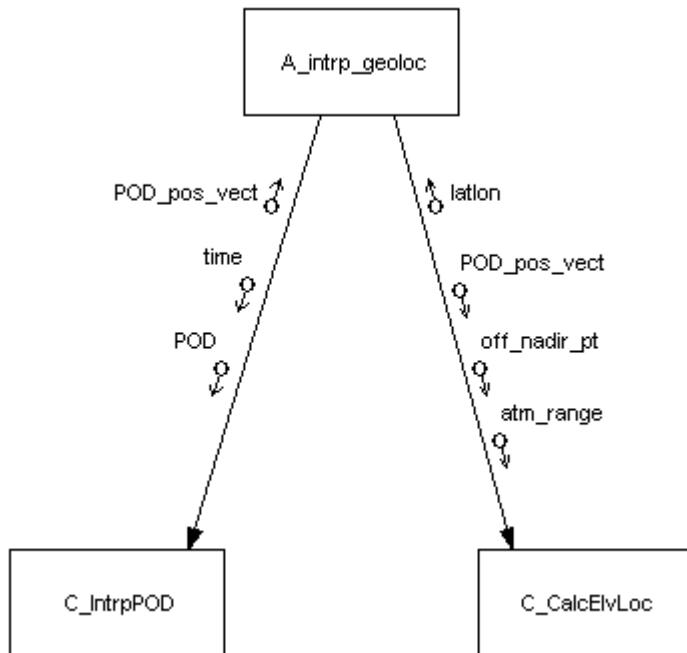
The following structure charts illustrate the organization of the atmosphere computations processes. The variable names are the same as those in the data flow diagrams (DFD's). Processes are called top to bottom and from left to right. Input variables point downwards to the process that is receiving them while output variables point upwards from the process which created them.

In general, the processes and variables are the same as those shown on the DFD's. There are a few differences, however. In two places, the structure charts are detailed to a level below the DFD's. This refers to the second and third charts which are expansions of the processes `A_intrp_geoloc` and `A_interp_met`, respectively. These expansions point out common functions (denoted by a `C_` in the process name) which the atmosphere subsystem shares with other subsystems. Another difference is that on the last structure chart, the processes `A_prod_write` and `A_wrapup` have been added. The process `A_prod_write` reformats the data to product format and writes the reformatted data to the output products. The process `A_wrapup` performs end-of-processing wrap-up functions.

# DRAFT

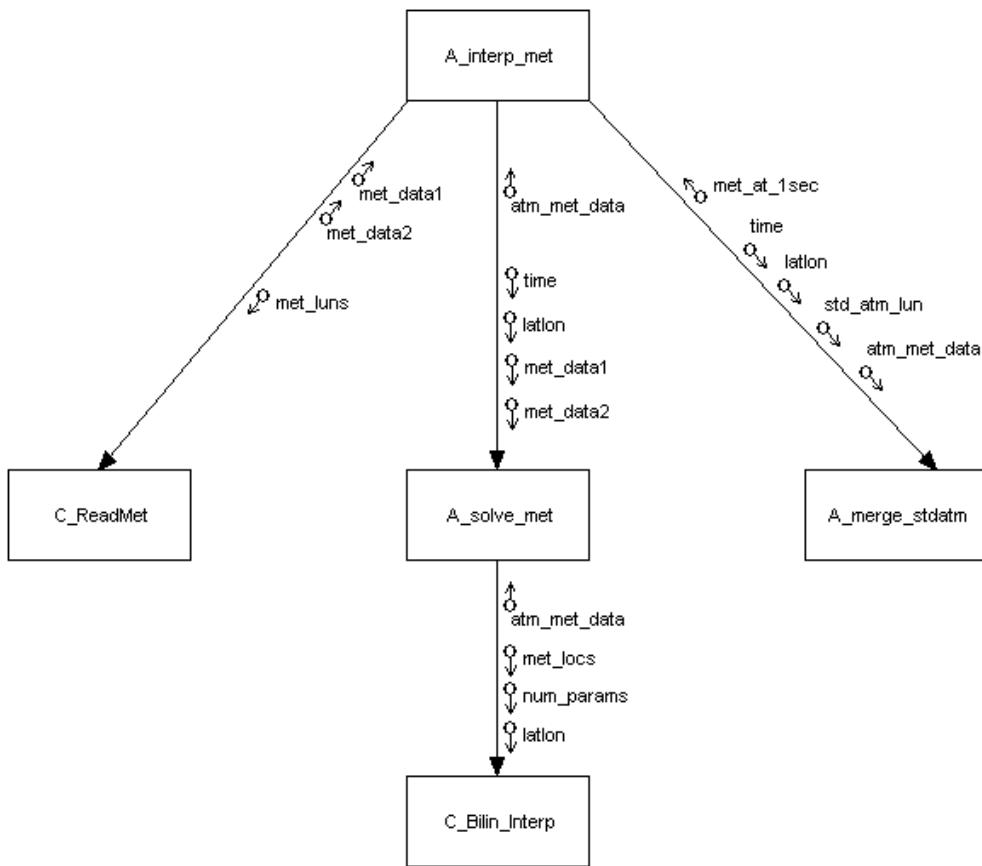


**Figure 58.** Level 1B and 2 Atmosphere Computations Structure Charts

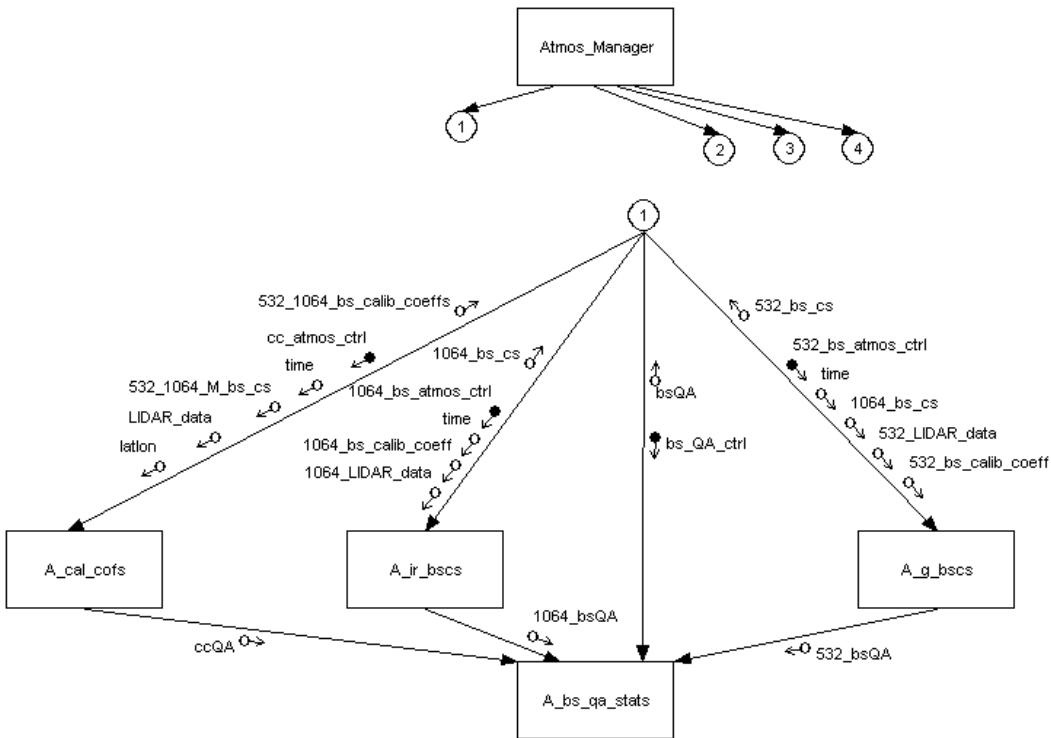


**Figure 59.**

# DRAFT

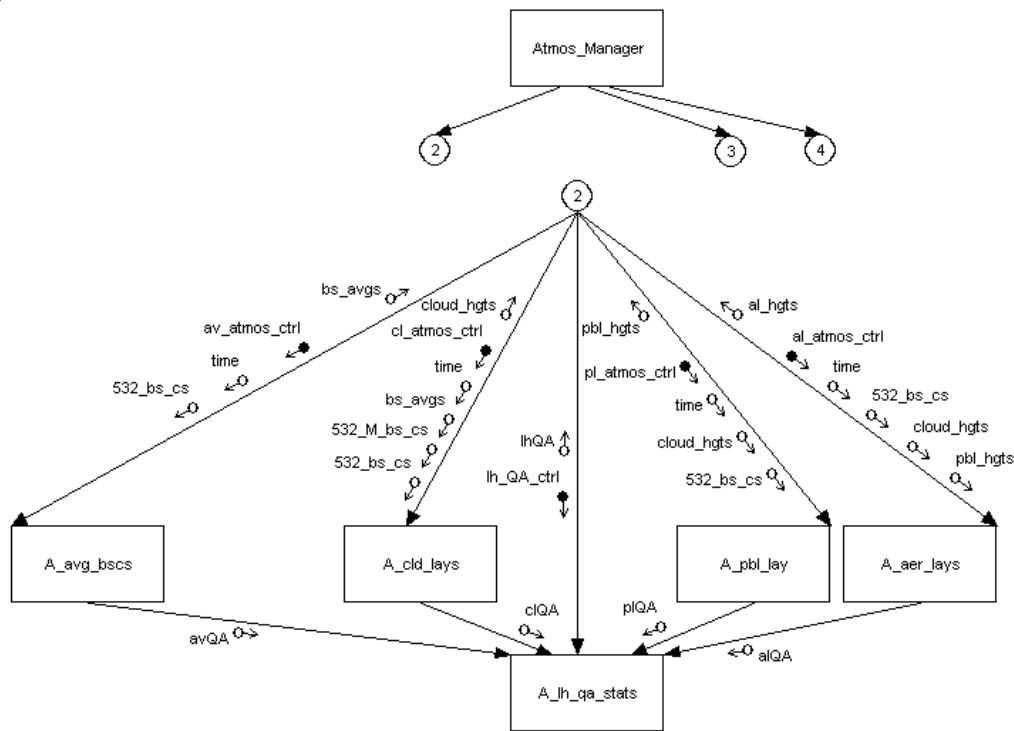


**Figure 60.**

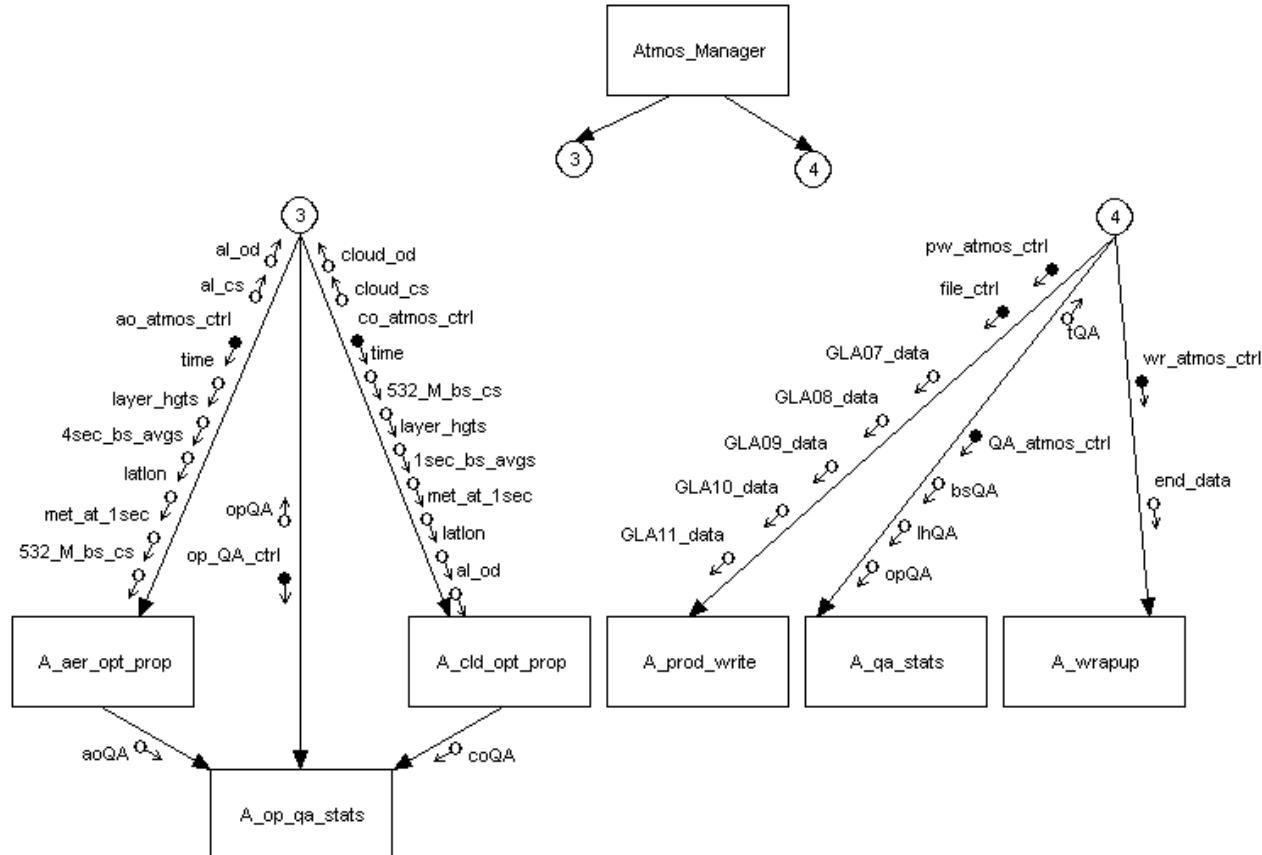


**Figure 61.**

# DRAFT

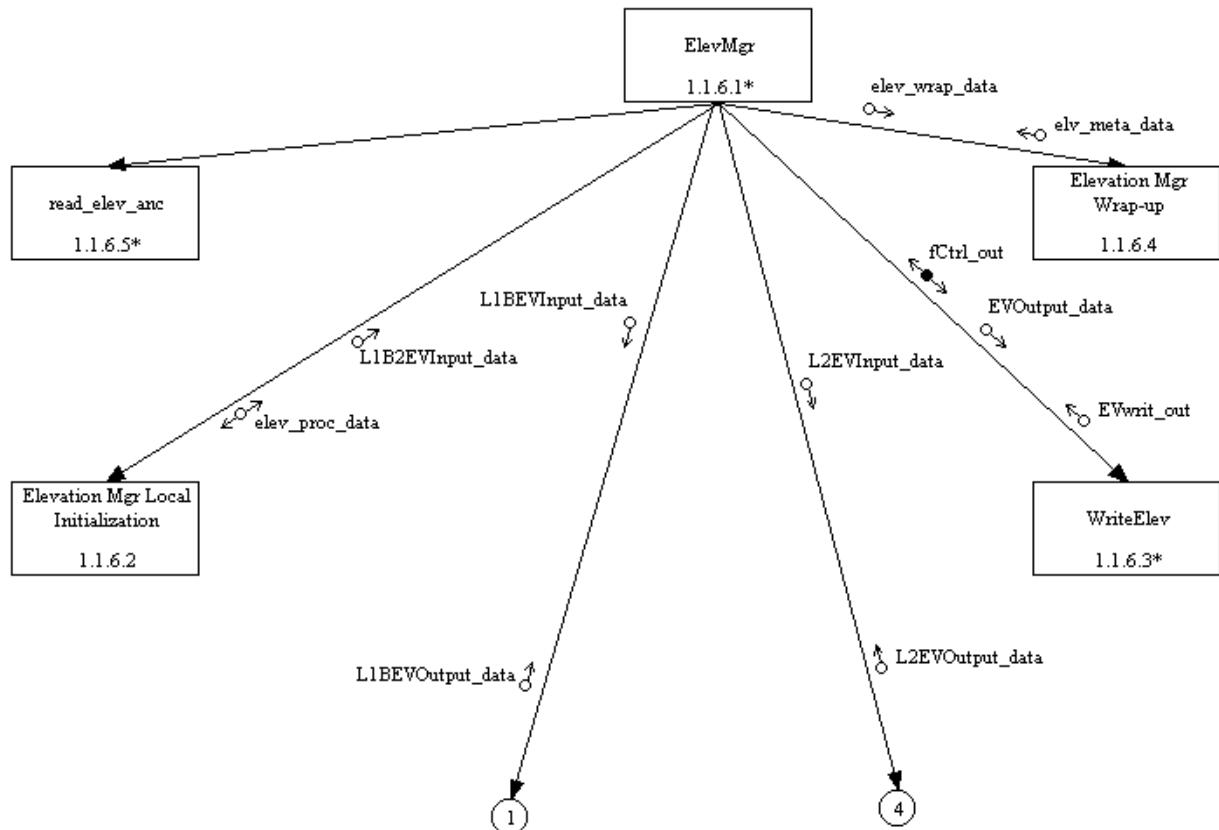


**Figure 62.**

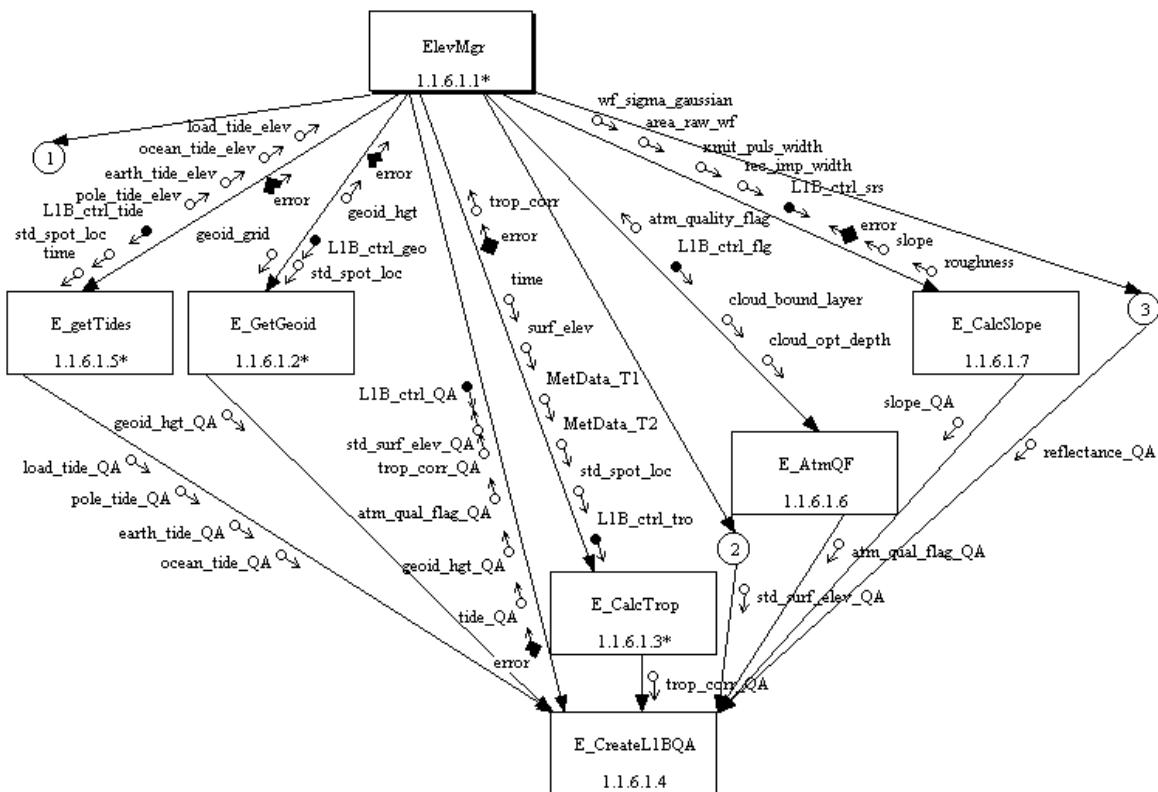


**Figure 63. Level 1B and 2 Elevation**

DRAFT

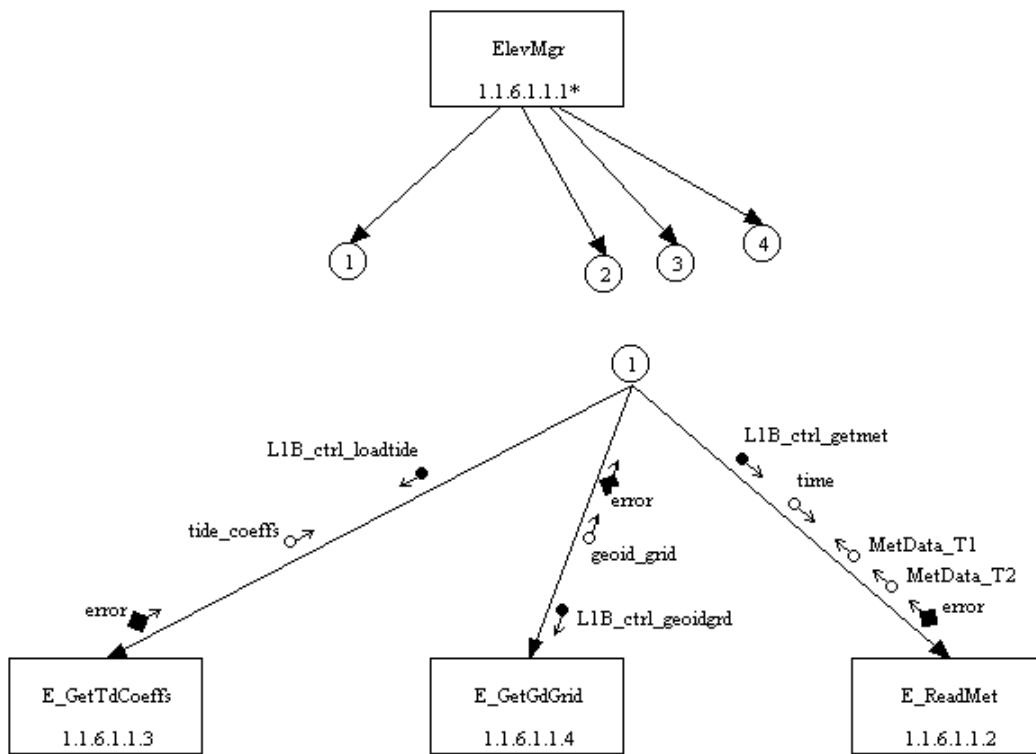


**Figure 64. Elevation Processing Manager Structure Chart**

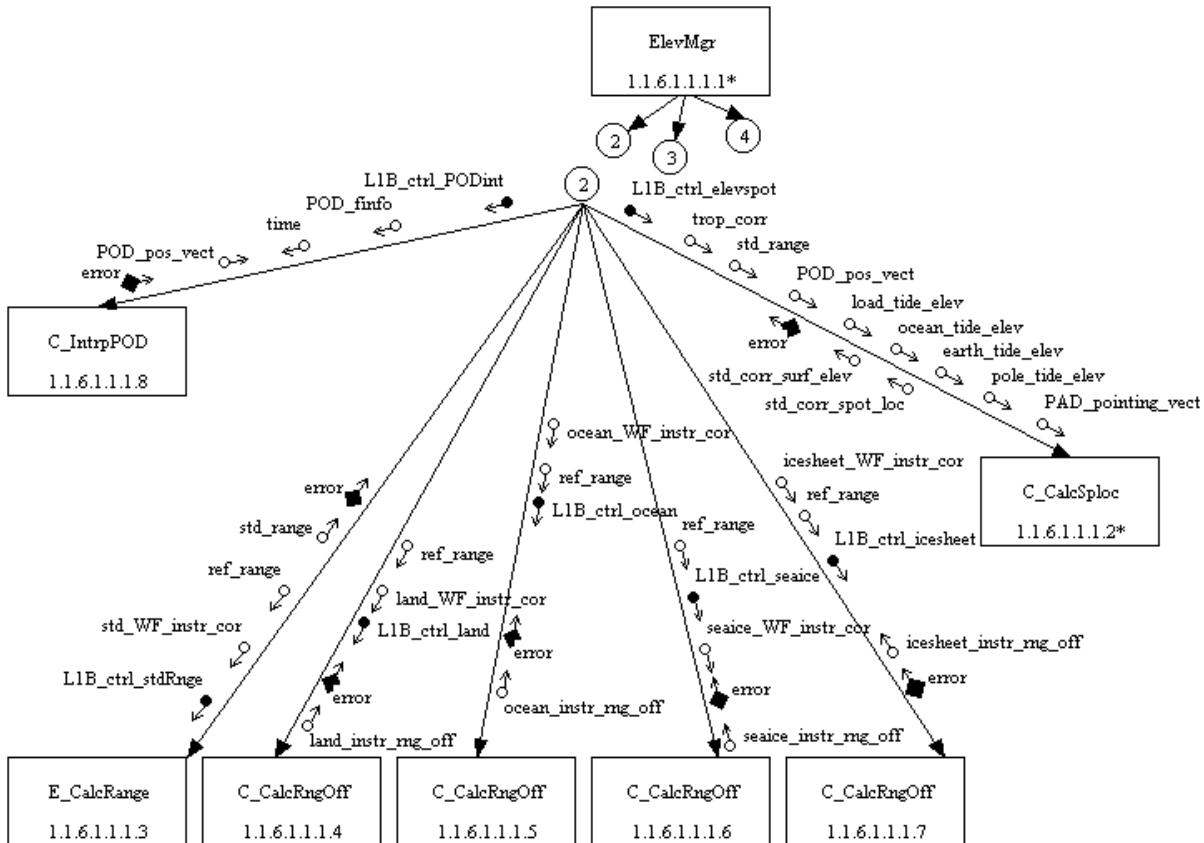


### **Figure 65. Calculate L1B Elevations Structure Chart**

# DRAFT

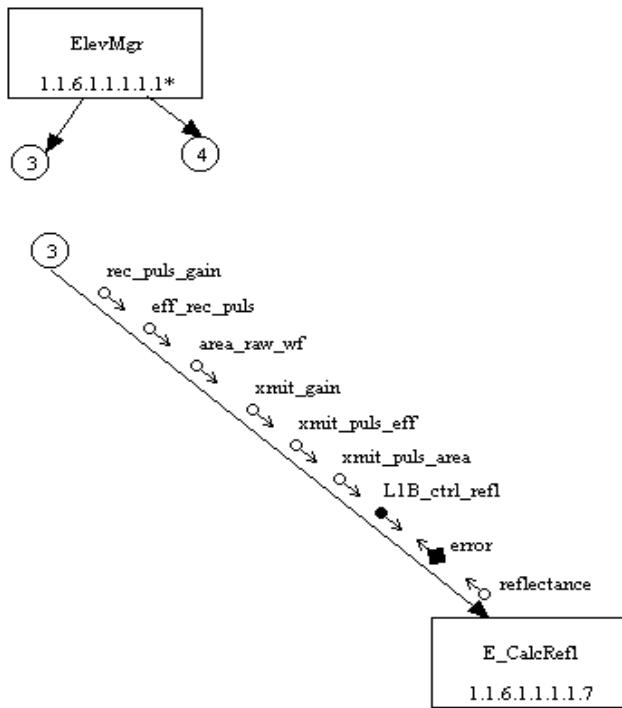


**Figure 66. Calculate L1B Elevations Structure Chart (Continued)**

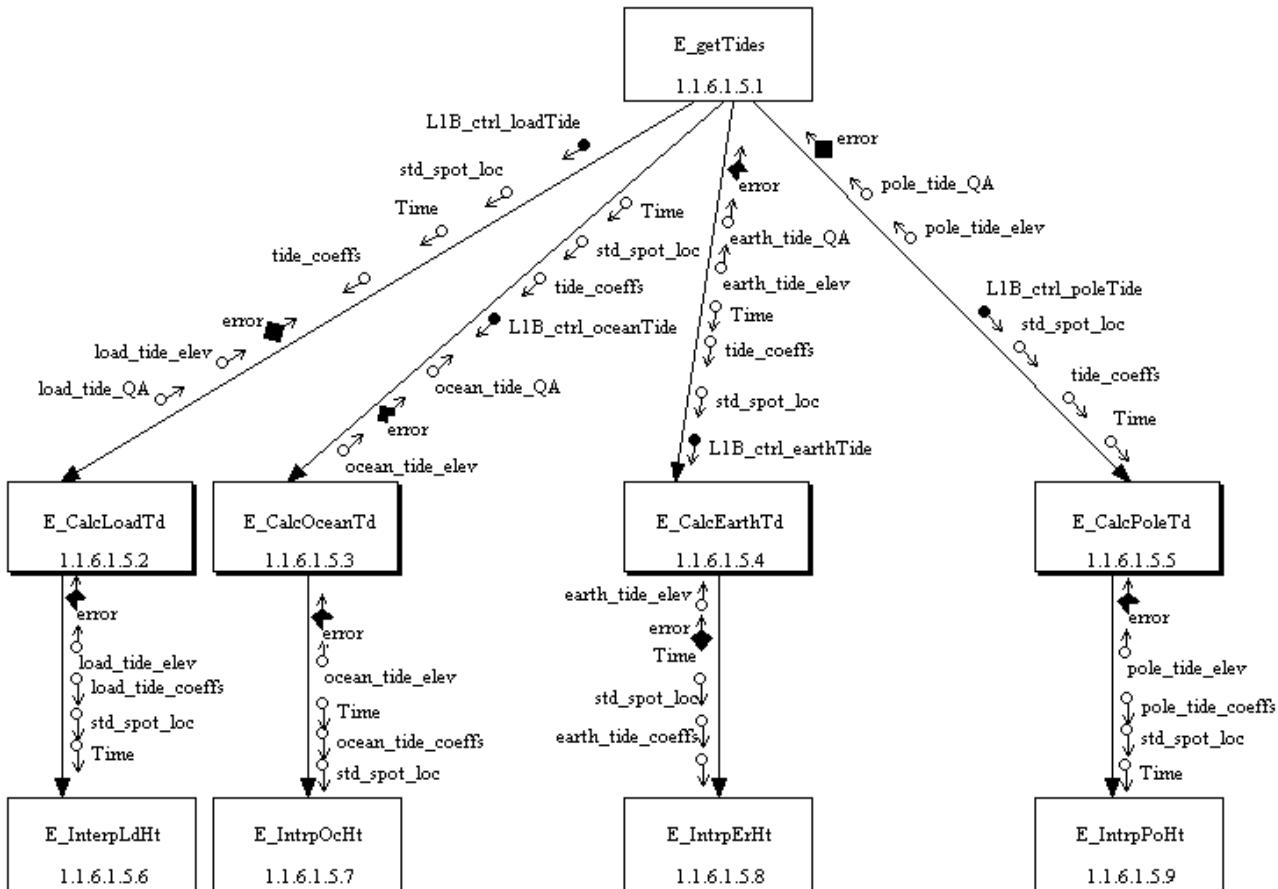


**Figure 67. Calculate L1B Elevations Structure Chart (Continued)**

# DRAFT

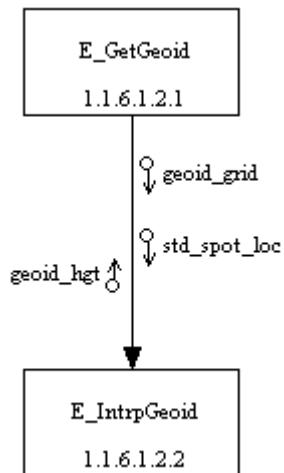


**Figure 68. Calculate L1B Elevations Structure Chart (Continued)**

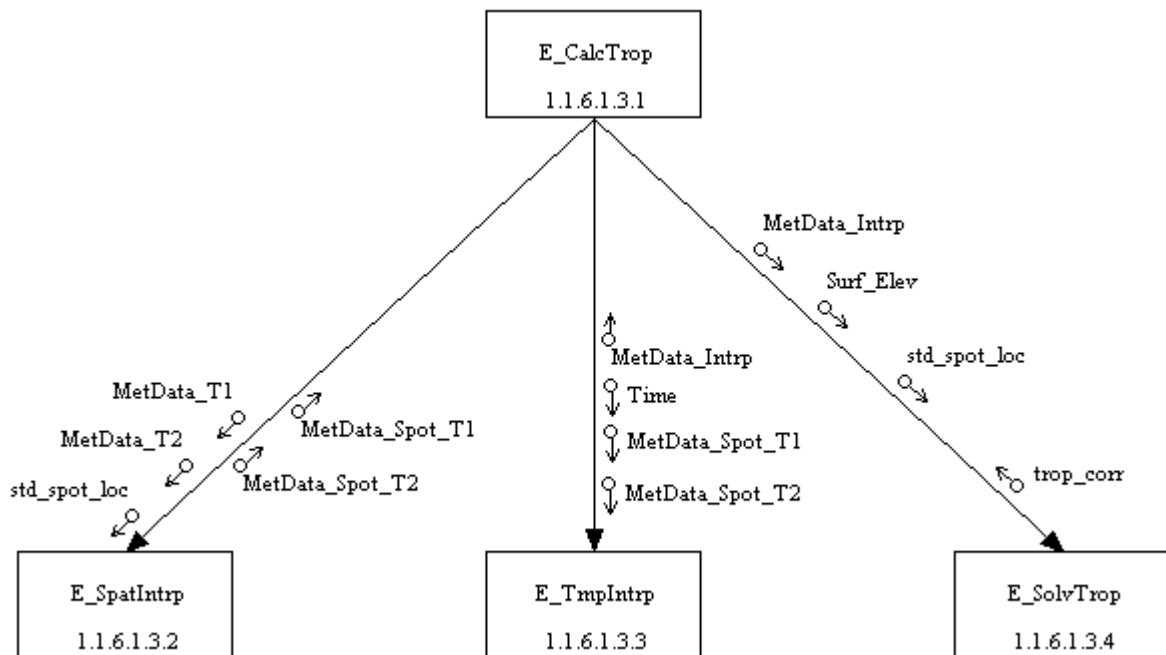


**Figure 69. Get Tides Structure Chart**

# DRAFT



**Figure 70. Get Geoid Structure Chart**



**Figure 71. Get Trop Corrections Structure Chart**

# DRAFT

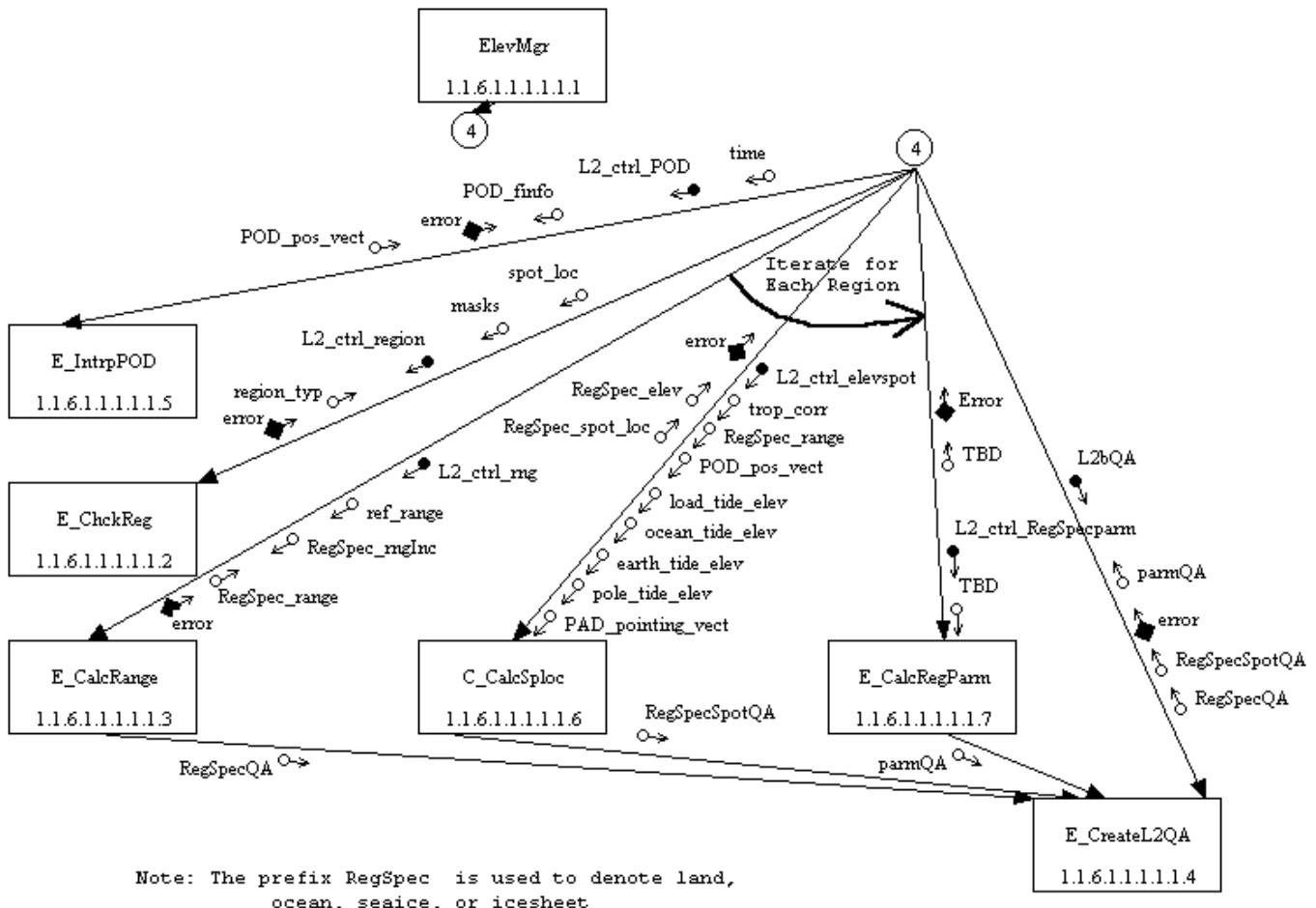
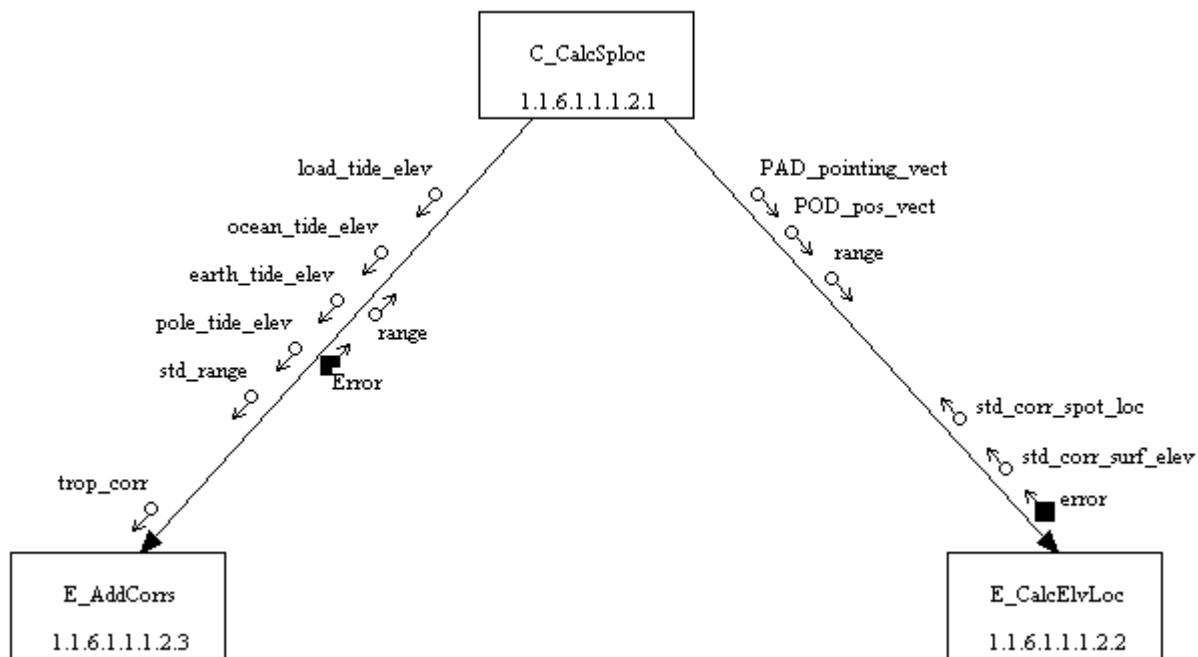


Figure 72. Calculate Spot Location Structure Chart



## **13 Utilities**

### **13.1 SCF to HDF**

### **13.2 Browse or display for QA**

### **13.3 Data Order/Merge**

## **14 Performance Statistics**

CPU utilization, throughput, etc

## **15 Appendix A**

### **Data Dictionary**

Dictionary will not be included here.(too big?)

## **16 Appendix B**

### **Variable Mapping( Structure Chart vs Pseudocode)**

#### ***16.1 The I-SIPS Controller***

##### ***16.1.1 The Executor***

There is no variable mapping for the executor.

##### ***16.1.2 Data Preparation, Formatting, Archiving***

There is no variable mapping for Data handling

# DRAFT

**Table 8. L1A Variable Mapping**

				Functions				
SC Var	PDL Var	File ID	File Element	L_Alt	L_AtM	L_Att	L_Eng	L_QA_Trnd
L0_ALT	I_l0alt	GLA00	1064 nm Laser Transmit Energy	i				
L0_ALT	I_l0alt	GLA00	Altimetry Packet Header	i				
L0_ALT	I_l0alt	GLA00	Detector Status (A or B)	i				
L0_ALT	I_l0alt	GLA00	1064 nm Programmable Gain Amplifier Setting	i				
L0_ALT	I_l0alt	GLA00	Delta-TIU Address Data	i				
L0_ALT	I_l0alt	GLA00	Filter and Tracking Parameters and Status	i				
L0_ALT	I_l0alt	GLA00	Laser Shot GPS Timing Vernier	i				
L0_ALT	I_l0alt	GLA00	1064 nm Background Signal	i				
L0_ALT	I_l0alt	GLA00	Spacecraft Time Code	i				
L0_ALT	I_l0alt	GLA00	A/D Samples	i				
alt_eng	d_altemp	n/a	Engineering data required for Altimetry EUC	i				
L0_ATM	I_l0atm	GLA00	1064 nm Lidar Data from 20 KM to 10 KM		i			
L0_ATM	I_l0atm	GLA00	532 nm Background Count Integration Intervals		i			
L0_ATM	I_l0atm	GLA00	532 nm Laser Transmit Energy		i			
L0_ATM	I_l0atm	GLA00	532 nm Lidar Data from 10 KM to -1 KM		i			
L0_ATM	I_l0atm	GLA00	532 nm Lidar Data from 20 KM to 10 KM		i			
L0_ATM	I_l0atm	GLA00	532 nm Lidar Data from 40 KM to 20 KM		i			
L0_ATM	I_l0atm	GLA00	1064 nm Lidar Data from 10 KM to -1 KM		i			
L0_ATM	I_l0atm	GLA00	Range Delay for Start of 532 nm Lidar Data 40 KM Segment		i			
L0_ATM	I_l0atm	GLA00	Lidar Packet Header		i			
L0_ATM	I_l0atm	GLA00	Spacecraft Time Code		i			
L0_ATM	I_l0atm	GLA00	Flags		i			
L0_ATM	I_l0atm	GLA00	1064 nm Background Data from -5 KM to -3.75 KM		i			
atm_eng	d_atmeng	n/a	Engineering data required for Atmosphere EUC		i			
L0_ATT	I_l0att	GLA00	Range Delay for Start of 1064 nm Lidar Data 20 KM Segment			i		
L0_ATT	I_l0att	GLA00	Spacecraft Time Code			i		
L0_ATT	I_l0att	GLA00	Star Camera			i		
L0_ATT	I_l0att	GLA00	Star Camera Data Header			i		
L0_ATT	I_l0att	GLA00	Laser Sector Address			i		
L0_ATT	I_l0att	GLA00	CCD Sector Star Camera Pointing Image			i		
L0_ATT	I_l0att	GLA00	GPS Broadcast UTC Offset			i		
L0_ATT	I_l0att	GLA00	Laser Shot Counter			i		
L0_ATT	I_l0att	GLA00	CCD Sector Laser Pointing Image			i		

# DRAFT

L0_ATT	I_l0att	GLA00	Laser Shot GPS Timing Vernier			i		
L0_ATT	I_l0att	GLA00	Gyro Centroid			i		
L0_ATT	I_l0att	GLA00	Gyro Sector Address			i		
L0_ATT	I_l0att	GLA00	CCD Sector Gyro Pointing Image			i		
L0_ATT	I_l0att	GLA00	Star Camera Centroid			i		
L0_ATT	I_l0att	GLA00	Star Sector Address			i		
L0_ATT	I_l0att	GLA00	Star Centroid			i		
L0_ATT	I_l0att	GLA00	Spacecraft Time Code			i		
L0_ATT	I_l0att	GLA00	Star Camera Sector Address			i		
L0_ATT	I_l0att	GLA00	LRS Data Header			i		
L0_ATT	I_l0att	GLA00	CCD Sector Star Image			i		
L0_ATT	I_l0att	GLA00	Laser Centroid			i		
L0_ATT	I_l0att	GLA00	Spacecraft Time Code			i		
L0_ATT	I_l0att	GLA00	GPS Data			i		
L0_ATT	I_l0att	GLA00	GPS Ephemeris and Velocity Message			i		
att_eng	d_atteng	n/a	Engineering data required for Attitude data configuration			i		
L0_ENG	I_l0eng	GLA00	GPS Data Header			i		
L0_ENG	I_l0eng	GLA00	Spacecraft Time Code			i		
L0_ENG	I_l0eng	GLA00	Header			i		
L0_ENG	I_l0eng	GLA00	HRG Gyro (Litton)			i		
L0_ENG	I_l0eng	GLA00	HOP Mechanism Drive Value			i		
L0_ENG	I_l0eng	GLA00	GPS Broadcast UTC Offset			i		
L0_ENG	I_l0eng	GLA00	Housekeeping Data Header			i		
L0_ENG	I_l0eng	GLA00	Laser A,B,C Select Status			i		
L0_ENG	I_l0eng	GLA00	Laser Shot Counter			i		
L0_ENG	I_l0eng	GLA00	Feedback Monitor Value (Quad Det)			i		
L0_ENG	I_l0eng	GLA00	Etalon Filter Temperature			i		
L0_ENG	I_l0eng	GLA00	Limit Position status			i		
L0_ENG	I_l0eng	GLA00	Miscellaneous Housekeeping			i		
L0_ENG	I_l0eng	GLA00	Motor Encoder Position (2 axis)			i		
L0_ENG	I_l0eng	GLA00	Motor Input Control Command			i		
L0_ENG	I_l0eng	GLA00	Power Converter Voltage			i		
L0_ENG	I_l0eng	GLA00	Power Converters Current			i		
L0_ENG	I_l0eng	GLA00	Power Converters Temperatures			i		
L0_ENG	I_l0eng	GLA00	GPS Broadcast Lat and Lon			i		
L0_ENG	I_l0eng	GLA00	Etalon Filter Heater Drive Control Point			i		
L0_ENG	I_l0eng	GLA00	HOP Mechanism Limit			i		
L0_ENG	I_l0eng	GLA00	Etalon Filter Feedback Monitor			i		
L0_ENG	I_l0eng	GLA00	Electronic Pump			i		

# DRAFT

L0_ENG	I_l0eng	GLA00	Electronic Pulse Trigger Timing				i	
L0_ENG	I_l0eng	GLA00	Electronic Monitors				i	
L0_ENG	I_l0eng	GLA00	HOP Mechanisms Monitor				i	
L0_ENG	I_l0eng	GLA00	Spacecraft Time Code				i	
L0_ENG	I_l0eng	GLA00	System Status				i	
L0_ENG	I_l0eng	GLA00	Temperature Controller Drive Value				i	
L0_ENG	I_l0eng	GLA00	Temperature Controller Set Points				i	
L0_ENG	I_l0eng	GLA00	Thermal Temperatures				i	
L1A_alt	d_l1aalt	GLA01	Altimetry Record Index	o				
L1A_alt	d_l1aalt	GLA01	Spacecraft Time	o				
L1A_alt	d_l1aalt	GLA01	Spacecraft Position and Velocity	o				
L1A_alt	d_l1aalt	GLA01	Spacecraft Position Time Tag	o				
L1A_alt	d_l1aalt	GLA01	DEM Grid Number	o				
L1A_alt	d_l1aalt	GLA01	DEM Flag	o				
L1A_alt	d_l1aalt	GLA01	Error Flags	o				
L1A_alt	d_l1aalt	GLA01	GPS Time	o				
L1A_alt	d_l1aalt	GLA01	GPS Position and Velocity	o				
L1A_alt	d_l1aalt	GLA01	GLAS Clock Time	o				
L1A_alt	d_l1aalt	GLA01	Orbital Information Flag	o				
L1A_alt	d_l1aalt	GLA01	Orbital Table Index	o				
L1A_alt	d_l1aalt	GLA01	Status Flags	o				
L1A_alt	d_l1aalt	GLA01	Filter Number	o				
L1A_alt	d_l1aalt	GLA01	Background RMS	o				
L1A_alt	d_l1aalt	GLA01	Return Pulse Quality Flag	o				
L1A_alt	d_l1aalt	GLA01	1064 nm Range to Last Gate	o				
L1A_alt	d_l1aalt	GLA01	Geolocation Calculation Parameters	o				
L1A_alt	d_l1aalt	GLA01	Calculated Delta Gain	o				
L1A_alt	d_l1aalt	GLA01	Peak Histogram Offset	o				
L1A_alt	d_l1aalt	GLA01	Range Window Offsets	o				
L1A_alt	d_l1aalt	GLA01	Range Window Start and Stop	o				
L1A_alt	d_l1aalt	GLA01	RMS Noise Calculation Location	o				
L1A_alt	d_l1aalt	GLA01	Waveform Compression Parameters	o				
L1A_alt	d_l1aalt	GLA01	Transmit Threshold	o				
L1A_alt	d_l1aalt	GLA01	Averaging Value for No Hit	o				
L1A_alt	d_l1aalt	GLA01	Averaging Values P and Q for Hit	o				
L1A_alt	d_l1aalt	GLA01	Range Bias Flag	o				
L1A_alt	d_l1aalt	GLA01	Transmit Time of First Sample	o				
L1A_alt	d_l1aalt	GLA01	1064 nm Programmable Gain Amplifier Setting	o				
L1A_alt	d_l1aalt	GLA01	Detector Status (A or B)	o				

# DRAFT

L1A_alt	d_11aalt	GLA01	Selected Filter Threshold Value	o				
L1A_alt	d_11aalt	GLA01	1064 nm Range Waveform	o				
L1A_alt	d_11aalt	GLA01	Transmit Sampled Waveform	o				
L1A_alt	d_11aalt	GLA01	Laser On Time	o				
L1A_alt	d_11aalt	GLA01	Laser Fire Time Delta	o				
L1A_alt	d_11aalt	GLA01	Echo Last Sample	o				
L1A_alt	d_11aalt	GLA01	Echo Leading Edge Offset	o				
L1A_alt	d_11aalt	GLA01	Echo Trailing Edge Offset	o				
L1A_alt	d_11aalt	GLA01	Echo Peak Offset	o				
L1A_alt	d_11aalt	GLA01	Echo Peak Value	o				
L1A_alt	d_11aalt	GLA01	Filter Weight Factors	o				
L1A_alt	d_11aalt	GLA01	1064 nm Laser Transmit Energy, counts	o				
L1A_alt	d_11aalt	GLA01	1064 nm Laser Transmit Energy	o				
L1A_alt	d_11aalt	GLA01	1064 nm Range Received Energy	o				
L1A_alt	d_11aalt	GLA01	1064 nm Background Signal - Atmosphere	o				
L1A_alt	d_11aalt	GLA01	1064 nm Range Received Energy, Counts	o				
L1A_alt	d_11aalt	GLA01	Filter Numbers Mask	o				
L1A_atm	d_11aatm	GLA02	Atmosphere Record Index		o			
L1A_atm	d_11aatm	GLA02	Time of First Sample		o			
L1A_atm	d_11aatm	GLA02	532 LIDAR Data Error Flag		o			
L1A_atm	d_11aatm	GLA02	532 nm LIDAR Data Shot Counter		o			
L1A_atm	d_11aatm	GLA02	532 nm Background		o			
L1A_atm	d_11aatm	GLA02	532 nm LIDAR Data from 10 KM to -1 KM		o			
L1A_atm	d_11aatm	GLA02	532 nm LIDAR Data from 20 KM to 10 KM		o			
L1A_atm	d_11aatm	GLA02	532 nm LIDAR Data Use Flag		o			
L1A_atm	d_11aatm	GLA02	532 nm LIDAR Data from 40 KM to 20 KM		o			
L1A_atm	d_11aatm	GLA02	532 nm LIDAR Data Quality Flag		o			
L1A_atm	d_11aatm	GLA02	532 nm LIDAR Data Range Delay to start of 40 KM Segment		o			
L1A_atm	d_11aatm	GLA02	532 nm Laser Transmit Energy		o			
L1A_atm	d_11aatm	GLA02	532 nm Laser Transmit Energy, counts		o			
L1A_atm	d_11aatm	GLA02	Photon Counter Range Delay		o			
L1A_atm	d_11aatm	GLA02	SPCM Raw Counts		o			
L1A_atm	d_11aatm	GLA02	SPCM Status		o			
L1A_atm	d_11aatm	GLA02	SPCM Background 2 and LIDAR Delay		o			
L1A_atm	d_11aatm	GLA02	SPCM Gate and Background 1 Delay		o			
L1A_atm	d_11aatm	GLA02	Photon Counter Range Bias		o			
L1A_atm	d_11aatm	GLA02	1064 nm Cloud Waveform Data Error Flag		o			
L1A_atm	d_11aatm	GLA02	1064 nm LIDAR Data Spare		o			
L1A_atm	d_11aatm	GLA02	1064 nm Cloud WF Shot Counter		o			

# DRAFT

L1A_atm	d_llaatm	GLA02	1064 nm Cloud WF Range Delay for Start of 20 KM Segment		o			
L1A_atm	d_llaatm	GLA02	1064 nm Cloud Waveform from 20 KM to 10 KM		o			
L1A_atm	d_llaatm	GLA02	1064 nm Cloud Waveform from 10 KM to -1 KM		o			
L1A_atm	d_llaatm	GLA02	1064 nm Predicted Cloud Top Height		o			
L1A_atm	d_llaatm	GLA02	1064 nm Cloud Waveform Use Flag		o			
L1A_atm	d_llaatm	GLA02	1064 nm Cloud Waveform Quality Flag		o			
L1A_atm	d_llaatm	GLA02	1064 nm Background from -5 KM to -3.75 KM		o			
L1A_atm	d_llaatm	GLA02	1064 nm Programmable Gain Amplifier Setting		o			
L1A_atm	d_llaatm	GLA02	A/D Output and Attenuation Setting		o			
L1A_atm	d_llaatm	GLA02	Cloud Digitizer Background 1 Delay		o			
L1A_atm	d_llaatm	GLA02	Cloud Digitizer Background 2 and LIDAR Delay		o			
L1A_atm	d_llaatm	GLA02	Cloud Digitizer Detector Status		o			
L1A_atm	d_llaatm	GLA02	Range Gate for Cloud Digitizer		o			
L1A_atm	d_llaatm	GLA02	Cloud Digitizer Range Bias		o			
L1A_atm	d_llaatm	GLA02	1064 nm Laser Transmit Energy, counts		o			
L1A_atm	d_llaatm	GLA02	1064 nm Laser Transmit Energy		o			
L1A_atm	d_llaatm	GLA02	1064 nm Range Received Energy, Counts		o			
L1A_atm	d_llaatm	GLA02	532 nm Channel Received Energy, counts		o			
L1A_atm	d_llaatm	GLA02	1064 nm Range Received Energy		o			
L1A_atm	d_llaatm	GLA02	532 nm Channel Received Energy		o			
L1A_atm	d_llaatm	GLA02	DEM Grid Number		o			
L1A_atm	d_llaatm	GLA02	Range from DEM		o			
L1A_atm	d_llaatm	GLA02	Location of Last Peak		o			
L1A_atm	d_llaatm	GLA02	Threshold Crossing		o			
L1A_atm	d_llaatm	GLA02	Etalon Filter Heater Drive Control Point		o			
L1A_atm	d_llaatm	GLA02	Etalon Filter Temperature		o			
L1A_atm	d_llaatm	GLA02	Etalon Filter Feedback Monitor		o			
L1A_atm	d_llaatm	GLA02	DEM Flag		o			
L1A_atm	d_llaatm	GLA02	532 nm Saturation Flag for 20 to 10 KM Segment		o			
L1A_atm	d_llaatm	GLA02	Ground Return Flag		o			
L1A_atm	d_llaatm	GLA02	Ground Return Energy		o			
L1A_atm	d_llaatm	GLA02	532 nm Saturation Flag for 40 to 20 KM Segment		o			
L1A_atm	d_llaatm	GLA02	532 nm Saturation Flag for 10 to -1 KM Segment		o			
L1A_eng	d_llaeeng	GLA03	Engineering Record Index			o		

# DRAFT

L1A_eng	d_11aeng	GLA03	GPS Broadcast Clock Offset				o	
L1A_eng	d_11aeng	GLA03	GPS Time				o	
L1A_eng	d_11aeng	GLA03	Calibration Mode (OTS)				o	
L1A_eng	d_11aeng	GLA03	Laser A B C Select Status				o	
L1A_eng	d_11aeng	GLA03	HOP Mechanisms Monitor				o	
L1A_eng	d_11aeng	GLA03	Power Converter Voltage				o	
L1A_eng	d_11aeng	GLA03	HOP Mechanism Limit				o	
L1A_eng	d_11aeng	GLA03	HOP Mechanism Drive Value				o	
L1A_eng	d_11aeng	GLA03	Motor Input Control Command				o	
L1A_eng	d_11aeng	GLA03	Motor Encoder Position (2 axis)				o	
L1A_eng	d_11aeng	GLA03	Power Converters Temperatures				o	
L1A_eng	d_11aeng	GLA03	Limit Position Status				o	
L1A_eng	d_11aeng	GLA03	GPS Broadcast Lat and Lon				o	
L1A_eng	d_11aeng	GLA03	Electronic Pump				o	
L1A_eng	d_11aeng	GLA03	Engineering				o	
L1A_eng	d_11aeng	GLA03	Feedback Monitor Value (Quad Det)				o	
L1A_eng	d_11aeng	GLA03	Laser Shot Counter				o	
L1A_eng	d_11aeng	GLA03	Etalon Filter Temperature				o	
L1A_eng	d_11aeng	GLA03	Etalon Filter Feedback Monitor				o	
L1A_eng	d_11aeng	GLA03	Power Converters Current				o	
L1A_eng	d_11aeng	GLA03	Etalon Filter Heater Drive Control Point				o	
L1A_eng	d_11aeng	GLA03	Electronic Monitors				o	
L1A_eng	d_11aeng	GLA03	Electronic Pulse Trigger Timing				o	
L1A_eng	d_11aeng	GLA03	Temperature Controller Set Points				o	
L1A_eng	d_11aeng	GLA03	Thermal Temperatures				o	
L1A_eng	d_11aeng	GLA03	Temperature Controller Drive Value				o	
L1A_eng	d_11aeng	GLA03	System Status				o	
L1A_eng	d_11aeng	GLA03	Peak Histogram				o	
L1A_eng	d_11aeng	GLA03	Weighting Factors Values				o	
L1A_eng	d_11aeng	GLA03	OTS of Waveform				o	
L1A_eng	d_11aeng	GLA03	Filtered Waveform				o	
L1A_eng	d_11aeng	GLA03	DEM Global Biases				o	
L1A_eng	d_11aeng	GLA03	Return Threshold Coefficients				o	
L1A_eng	d_11aeng	GLA03	Number of Ocean Samples				o	
L1A_eng	d_11aeng	GLA03	Number of Waveform Samples				o	
L1A_eng	d_11aeng	GLA03	Number of Elements Averaged at p and q				o	
L1A_eng	d_11aeng	GLA03	Filter Echo Threshold				o	
L1A_eng	d_11aeng	GLA03	Gain Parameters				o	
L1A_eng	d_11aeng	GLA03	Range Window Location				o	

# DRAFT

L1A_eng	d_11aeng	GLA03	Range Window Size				o	
L1A_eng	d_11aeng	GLA03	Telemetry Headers				o	
L1A_att	d_11aatt	GLA04	SRS and GPS Record Index				o	
L1A_att	d_11aatt	GLA04	GPS Time				o	
L1A_att	d_11aatt	GLA04	GPS Broadcast Clock Offset				o	
L1A_att	d_11aatt	GLA04	GPS ID				o	
L1A_att	d_11aatt	GLA04	GPS Quality Flag				o	
L1A_att	d_11aatt	GLA04	Pseudorange L2				o	
L1A_att	d_11aatt	GLA04	Carrier Phase L1				o	
L1A_att	d_11aatt	GLA04	Carrier Phase L2				o	
L1A_att	d_11aatt	GLA04	Pseudorange L1				o	
L1A_att	d_11aatt	GLA04	GPS Receiver Time				o	
L1A_att	d_11aatt	GLA04	GPS SNR				o	
L1A_att	d_11aatt	GLA04	Star (Laser) Coordinate X				o	
L1A_att	d_11aatt	GLA04	Star (Laser) Coordinate Y				o	
L1A_att	d_11aatt	GLA04	Star Camera Time				o	
L1A_att	d_11aatt	GLA04	Star (Laser) Intensity				o	
L1A_att	d_11aatt	GLA04	Star Camera Image				o	
L1A_att	d_11aatt	GLA04	Star Sector Address				o	
L1A_att	d_11aatt	GLA04	Star Centroid				o	
L1A_att	d_11aatt	GLA04	Star Camera Centroid				o	
L1A_att	d_11aatt	GLA04	Star Camera Sector Address				o	
L1A_att	d_11aatt	GLA04	CCD Sector Gyro Pointing Image				o	
L1A_att	d_11aatt	GLA04	Gyro Centroid				o	
L1A_att	d_11aatt	GLA04	Laser Sector Address				o	
L1A_att	d_11aatt	GLA04	CCD Sector Laser Pointing Image				o	
L1A_att	d_11aatt	GLA04	Gyro Sector Address				o	
L1A_att	d_11aatt	GLA04	CCD Sector Star Image				o	
L1A_att	d_11aatt	GLA04	Laser Centroid				o	
L1A_att	d_11aatt	GLA04	CCD Sector Star Camera Pointing Image				o	
L1A_att	d_11aatt	GLA04	HRG Gyro (Litton)				o	
L1A_att	d_11aatt	GLA04	Spacecraft Star Camera Centroid				o	
L1A_att	d_11aatt	GLA04	Time Correction				o	
L1A_att	d_11aatt	GLA04	Time of First Pulse				o	
L1A_att	d_11aatt	GLA04	1064 nm Range TIU Time				o	
cQA		GLA ANC 06						o
trend_data		GLA ANC 06						o
engQA_trend	d_engqatrnd	GLA ANC 06					o	i
attQA_trend	d_attqatrnd	GLA ANC 06					o	i

# DRAFT

atmQA_trend	d_atmqatrnd	GLA ANC 06				o			i
altQA_trend	d_altqatrnd	GLA ANC 06				o			i
result_code	i_alt_res_code	n/a	Result code set by the L1A Altimeter ATBD			o			
result_code	i_atm_res_code	n/a	Result code set by the L1A Atmosphere ATBD			o			
result_code	i_att_res_code	n/a	Result code set by the L1A Attitude ATBD			o			
result_code	i_eng_res_code	n/a	Result code set by the L1A Engineering ATBD					o	
result_code	i_QAT_res_code	n/a	Result code set by the L1A QA and Trend Process						o

## 16.2 Level 1B Waveforms

**Table 9.**

SC Var	PDL Var	Dim	File ID	File Element	WF_Manager	W_Assess	W_DetGeoSurTyp	W_CalcOtherCh	W_CreQASStats	W_ClkASat	W_DefinNsSigBE	W_CalcCtMxAvAs	W_CalcSdRCorr	W_CreaQASStats	W_DetAttitude	W_DetOrbit	W_DetGeoloc	W_DetSurfType	W_CreGsQASStats	W_ParamWithFit	W_ParamLand	W_ParamSeIce	W_ParamOcean	W_ParamIcsSheet	W_CalcPQASStats
?	i_wfRecNdx	1	GLA05	Waveform Record Index	?																				
?	d_las1stTime	1	GLA05	Time of First Laser Pulse	I	I																			
time	d_deltaLsrTime(40)	40	GLA05	Laser Shot Time Deltas	I	I																			
spot3dStdUncor	d_spotLat, d_spotLon, d_spotElev	3	GLA05	Spot 1 Coordinate Data	O	O																			
?	r_deltaSpot.lat(40), r_deltaSpot.lon(40), r_deltaSpot.elev(40)	3x40	GLA05	Delta Spot Coordinates	O																				
PAD_pointngVect	d_lasITRF	3	GLA05	PAD Pointing Vector	O	O																			
POD_pos_vect	d_scITRF	3	GLA05	POD Fixed Position Vector	O	O																			
?	lPadPod40QF	3	GLA05	PAD/POD at 40 per Second Quality Flag	?																				
?	i_onBErrFlgs	40	GLA05	On-board Error Flags	?																				
surf_type	i_surf_type	40	GLA05	Surface Type	O	O	I																		
?	lFrmUseFlg	1	GLA05	Frame Use Flag	?																				
ref_range	d_refRng	40	GLA05	Reference Range	?																				
?	wfParRflecCorr	40	GLA05	Reflectance Correction, from WF Parameterization	O																				

# DRAFT

std_range_corr	d_stdRngOff	40	GLA05	Standard Range Offset	O	O																		
?	lWfQualFlag	40	GLA05	Waveform Quality Flag	O																			
?	wfRngRcvdEn	40	GLA05	1064nm Range Received Energy	I																			
wf_shape_char	wfRAreaSigRtn	40	GLA05	Area for Signal Return of the Raw WF	O	O																		
wf_signal_char	wfSmSigB, wfSmSigE	2x40	GLA05	Beginning and End of Signal from Smooth WF	O	O																		
wf_signal_char	wfRSigB, wfRSigE	2x40	GLA05	Beginning and Ending of Signal From Raw WF	O	O																		
wf_parameters	d_chi2ISO	40	GLA05	Chi Square - Ice Sheet, Sea Ice, or Ocean	O		O																	
wf_parameters	d_chi2L	40	GLA05	Chi Square - Land	O		O																	
wf_shape_char	wfRMaxAmp	40	GLA05	Max Amp of the Raw Waveform	O	O																		
wf_shape_char	wfSmPeakAmp	40	GLA05	Peak Amplitude of Smooth WF	O	O																		
?	wfRsatSigPerc	40	GLA05	Percent of Saturated Signal From Raw WF	O																			
wf_signal_char	wfSmCentOff	40	GLA05	Range Offset to Centroid from Smooth WF	O	O																		
wf_shape_char	wfRCentOff	40	GLA05	Range Offset to Centroid of Raw WF Signal	O	O																		
wf_parameters	r_rngOffThX	40	GLA05	Range Offset to First Threshold Crossing	?	?																		
wf_parameters	d_sgmlISO	40	GLA05	Sigma of Parameterization to WF - Ice Sheet, Sea Ice, or Ocean	O		O																	
wf_parameters	d_sgml	40	GLA05	Sigma of Parameterization to WF - Land	O		O																	
wf_shape_char	wfRskew, wfRCurt	2x40	GLA05	Skewness and Curtosis of Raw WF Signal Return	O	O																		
wf_parameters	d_sgml	19x40	GLA05	WF Parameter Sigma - Land	O		O																	
wf_parameters	d_sgmlISO	7x40	GLA05	WF Parameter Sigmas - Ice Sheet, Sea Ice, or Ocean	O		O																	
wf_parameters	w_ampL(6), w_sigmaL(6), w_posL(6), w_noisL	19x40	GLA05	WF Parameters - Land		?																		

DRAFT

# DRAFT

surf_type_grid				Surface-Type Grid		I											I						
tel_saturat ion				Telemetered Saturation					I														
time		1		Time			I										I	I					
w_ctrl_aw				Control Input for W_Assess	O	I																	
w_ctrl_ge o_sur				Control Input for W_DetGeoSurTy p	O		I																
w_ctrl_oth				Control Input for W_CalcOtherCh	O			I												I			
w_ctrl_Q A				Control Input for W_CreQAStats	O				I														
w_ctrl_aw _sat				Control Input for W_Ck4Sat		O				I													
w_ctrl_aw _sig				Control Input for W_DefnNsSigBE	O					I													
w_ctrl_aw _sh				Control Input for W_CalcCtMxAr As	O						I												
w_ctrl_aw _r				Control Input for W_CalcStdRCorr	O						I												
w_ctrl_aw QA				Control Input for W_CreAsQAStat s	O							I											
w_ctrl_att				Control Input for W_DetAttitude		O							I										
w_ctrl_or bit				Control Input for W_DetOrbit		O								I									
w_ctrl_ge o				Control Input for W_DetGeoloc		O								I									
w_ctrl_sur				Control Input for W_DetSurfType		O									I								
w_ctrl_ge oQA				Control Input for W_CreGsQAStat s		O										I							
w_ctrl_oth _par				Control Input for W_ParamWithFit			O											I					
w_ctrl_oth _l				Control Input for W_ParamLand													O	I					
w_ctrl_oth _si				Control Input for W_ParamSeIce													O		I				
w_ctrl_oth _oc				Control Input for W_ParamOcean													O		I				
w_ctrl_oth _is				Control Input for W_ParamIcSheet													O			I			
w_ctrl_oth QA				Control Input for W_CrePfQAStats			O														I		
wf				Waveforms					I	I													
wf_attQA				QA info from W_DetAttitude									O				I						
wf_general				General Waveform		O																	

# DRAFT

Characteristics											
_char											
wf_geoloc_QA			QA info from W_DetGeoloc						O	I	
wf_nOtherParam			Waveforms and Other WF Parameters	I	I		I	I		I	I
wf_orbQA			QA info from W_DetOrbit						O	I	
wf_oth_QA			QA info from W_ParamWithFit							O	O
wf_parameters			WF Parameters		O					O	O
wf_sat_flag			WF Saturation Flag			O					
wf_sat_QA			QA info from W_Ck4Sat			O		I			
wf_shape_char			WF Shape Characteristics				I				
wf_shape_QA			QA info from W_CalcCtMxArAs				O	I			
wf_signal_char			WF Signal Characteristics			I					
wf_signal_QA			QA info from W_DefnNsSigBE			O		I			
wf_std_rangeQA			QA info from W_CalcStdRCorr				O	I			
wf_surf_params			WF Surface Parameters							O	O
wf_surfTypeQA			QA info from W_DetSurfType						O	I	
wvQA			QA info from Level 1B Waveforms		O						

### 16.3 Level 1B and 2 Atmosphere Computations

The following table maps the variable names used in the data flow diagrams and structure charts to the actual variable names that will be used in the PDL and Fortran 90 code. Since the structure chart variables are so general, one variable can represent many PDL variables. Included in the table for each PDL variable is its name, array dimension, output product name, short description, and whether it is an input (i) or an output (o) to each process. An “x” under a process name denotes that the variable is internal to the process rather than an input or output.

In the naming convention for the PDL variable names, the first character indicates that it is either a 4 byte integer (i) or an 8 byte real (d). If the second character is a number it indicates the frequency of the data (i.e. 40 Hz “40”, 5 Hz “5”, 1 sec “1”, 4 sec “4”, 20 sec “20”). Since the processes work with 1 second records, if the frequency is less than 1 second, the variable will be an array with one dimension the size of the frequency. A variable that ends its name in an “\_f” is a flag (i.e. quality flag “qf”, use flag “uf”, availability flag “af”).

PDL variables that do not have structure chart variable names are parameters that are passed from one product to another, but are not used in any of the data processes. Variables that have “internal” for a file ID are not on an output product, but are used in the data processing. The Structure chart variables at the bottom of the last table are combinations of other structure chart variables.

# DRAFT

**Table 10.**

Structure Chart Variable	PDL Variables	Dim	File ID	File Element	A_imrp_geoloc	A_imrp_met	A_mbsscs	A_cal_cofs	A_ir_bsces	A_g_bsces	A_bs_qa_stats	A_avg_bsces	A_cld_lays	A_phl_lay	A_aer_lays	A_lh_qa_stats	A_aer_opt_prop	A_cld_opt_prop	A_op_qa_stats	A_qa_stats	A_prod_write	A_wrapup
1064_LIDAR_data	d1_ir_bg	2	GLA02	1064 nm Background																		
1064_LIDAR_data	d1_ir_tx_ener	1	GLA02	1064 nm Laser Transmit Energy																		
1064_LIDAR_data	d40_ir_bg	2	GLA02	1064 nm Background																		
1064_LIDAR_data	d40_ir_id	144	GLA02	1064 nm Lidar Data from 10 KM to -1 KM																		
1064_LIDAR_data	d40_ir_tx_ener	1	GLA02	1064 nm Laser Transmit Energy																		
1064_LIDAR_data	d5_ir_bg	2	GLA02	1064 nm Background																		
1064_LIDAR_data	d5_ir_id	131	GLA02	1064 nm Lidar Data from 20 KM to 10 KM																		
1064_LIDAR_data	d5_ir_tx_ener	1	GLA02	1064 nm Laser Transmit Energy																		
1064_LIDAR_data	i1_ir_bg_ef	1	GLA02	1064 nm Background Use Flag; 3 values																		
1064_LIDAR_data	i1_ir_lid_qf	1	GLA02	1064 nm Lidar Data Quality Flag																		
1064_LIDAR_data	i1_ir_lid_ef	1	GLA02	1064 nm Lidar Data Use Flag																		
1064_LIDAR_data	i1_ir_shot_ctr	1	GLA02	1064 nm Laser Shot Counter																		
1064_LIDAR_data	i40_ir_lid_ef	1	GLA02	1064 nm Lidar Data Error Flag																		
1064_LIDAR_data	i40_ir_txen_qf	1	GLA02	1064 nm Laser Transmit Energy Quality Flag																		
532_LIDAR_data	d1_g_bg	2	GLA02	532 nm Background																		
532_LIDAR_data	d1_g_lid	261	GLA02	532 nm LIDAR Data from 40 KM to 20 KM																		
532_LIDAR_data	d1_g_tx_ener	1	GLA02	532 nm Laser Transmit Energy																		
532_LIDAR_data	d40_g_bg	2	GLA02	532 nm Background																		
532_LIDAR_data	d40_g_lid	144	GLA02	532 nm LIDAR Data from 10 KM to -1 KM																		
532_LIDAR_data	d40_g_tx_ener	1	GLA02	532 nm Laser Transmit Energy																		
532_LIDAR_data	d5_g_bg	2	GLA02	532 nm Background																		
532_LIDAR_data	d5_g_lid	131	GLA02	532 nm LIDAR Data from 20 KM to 10 KM																		
532_LIDAR_data	d5_g_tx_ener	1	GLA02	532 nm Laser Transmit Energy																		
532_LIDAR_data	i1_g_bg_ef	1	GLA02	532 nm Background Use Flag; 3 values																		
532_LIDAR_data	i1_g_lid_qf	1	GLA02	532 nm Lidar Data Quality Flag																		
532_LIDAR_data	i1_g_lid_ef	1	GLA02	532 nm Lidar Data Use Flag																		
532_LIDAR_data	i1_g_sat_f	261	GLA02	532 nm Saturation Flag for 40 to 20 KM Segment																		
532_LIDAR_data	i1_g_shot_ctr	1	GLA02	532 nm LIDAR Data Shot Counter																		
532_LIDAR_data	i40_g_lid_ef	1	GLA02	532 LIDAR Data Error Flag																		
532_LIDAR_data	i40_g_sat_f	144	GLA02	532 nm Saturation Flag for 10 to -1 KM Segment																		
532_LIDAR_data	i40_g_txen_qf	1	GLA02	532 nm Laser Transmit Energy Quality Flag																		
532_LIDAR_data	i5_g_sat_f	131	GLA02	532 nm Saturation Flag for 20 to 10 KM Segment																		
atm_range	d40_elev_pr	1	GLA02	Elevation based on peak of return																		
atm_range	d40_elev_tr	1	GLA02	Elevation based on threshold of return																		
atm_range	d40_thr_xg	1	GLA02	Threshold Crossing																		
time	d1_time	1	GLA02	Time of First Sample																		
		1	GLA02	Atmosphere Record Index																		
1064_bs_calib_coeff	d1_ir_cal_cof	3	GLA07	1064 nm Backscatter Calibration Value																		
1064_bs_calib_coeff	i1_ir_calcof_qf	1	GLA07	1064 nm Backscatter Calibration Quality Flag																		
1064_bs_cs	d40_ir_bsces	144	GLA07	1064 nm Attenuated Backscatter Vertical 10 to -1 KM Profile																		
1064_bs_cs	d5_ir_bsces	274	GLA07	1064 nm Attenuated Backscatter Vertical Full Profile																		
1064_bs_cs	i1_ir_bsces_qf	1	GLA07	1064 nm Attenuated Backscatter Vertical Profile Quality Flag																		
1064_bs_cs	i1_ir_bsces_ef	1	GLA07	1064 nm Attenuated Backscatter Vertical Profile Use Flag																		
1064_LIDAR_data	d1_ir_bg	2	GLA07	1064 nm Background																		
1064_LIDAR_data	d40_ir_bg	2	GLA07	1064 nm Background																		
1064_LIDAR_data	d40_ir_txen_qf	1	GLA07	1064 nm Laser Transmit Energy Quality Flag																		
1064_LIDAR_data	d5_ir_bg	2	GLA07	1064 nm Background																		
1064_M_bs_cs	d1_ir_mbsscs	274	GLA07	1064 nm Molecular Backscatter Cross Section Profile																		
532_bs_calib_coeff	d1_g_cal_cof	3	GLA07	532 nm Backscatter Calibration Value																		
532_bs_calib_coeff	i1_g_calcof_qf	1	GLA07	532 nm Backscatter Calibration Quality Flag																		
532_bs_cs	d1_g_int_ret	261	GLA07	532 nm Integrated Return from 20-40 km																		
532_bs_cs	d40_g_bsces	144	GLA07	532-1064 nm Merged Attenuated Backscatter Vertical 10 KM to																		
532_bs_cs	d5_g_bsces	534	GLA07	532-1064 nm Merged Attenuated Backscatter Vertical Full Prof																		
532_bs_cs	i1_g_bsces_qf	1	GLA07	532 nm Attenuated Backscatter Vertical Profile Quality Flag																		
532_bs_cs	i1_g_bsces_ef	1	GLA07	532 nm Attenuated Backscatter Vertical Profile Use Flag																		
532_LIDAR_data	d1_g_bg	2	GLA07	532 nm Background																		
532_LIDAR_data	d40_g_bg	2	GLA07	532 nm Background																		
532_LIDAR_data	d40_g_txen_qf	1	GLA07	532 nm Laser Transmit Energy Quality Flag																		
532_LIDAR_data	d5_g_bg	2	GLA07	532 nm Background																		
532_LIDAR_data	i1_cal_dnf	1	GLA07	Calibration day/night flag																		
532_M_bs_cs	d1_g_mbsscs	534	GLA07	532 nm Molecular Backscatter Cross Section Profile																		
atm_range	d40_elev_pr	1	GLA07	Surface Elevation - Peak of Return																		
atm_range	d40_elev_tr	1	GLA07	Surface Elevation - Threshold of Return																		
atm_range	d40_thr_xg	1	GLA07	Threshold Crossing																		
latlon	d1_prof_crd	3	GLA07	Profile Coordinate Data																		
latlon	i1_pod_qf	1	GLA07	POD Quality Flag																		
off_nadir_pt	d1_off_nad_pt	3	GLA07	PAD Controlled Pointing Vector																		
off_nadir_pt	i1_off_nad_qf	1	GLA07	Controlled Pointing Vector Quality Flag																		
time	d1_time	1	GLA07	Time of First Sample																		
		1	GLA07	Backscatter Record Index																		
		1	GLA07	Solar Incidence Angle																		
		1	GLA07	Start Range of Backscatter Profile																		

# DRAFT

**Table 11.**

Structure Chart Variable	PDL Variables	Dim	File ID	File Element	A_intrp_geoloc	A_interp_met	A_mhsses	A_cal_cofs	A_ir_bsbs	A_g_bsbs	A_bs_qa_stats	A_avg_bsbs	A_elt_lays	A_phl_lay	A_aer_lays	A_lh_qa_stats	A_aer_opt_prop	A_cld_opt_prop	A_qp_qa_stats	A_qa_stats	A_prod_write	A_wrapup
al_htgs	d20_aer_bot	3	GLA08	20-40 KM Aerosol Layer Bottom																		
al_htgs	d20_aer_top	3	GLA08	20-40 KM Aerosol Layer Top																		
al_htgs	d4_aer_bot	5	GLA08	Below 20 KM Aerosol Layer Bottom																		
al_htgs	d4_aer_top	5	GLA08	Below 20 KM Aerosol Layer Top																		
al_htgs	i20_aer_lay_qf	3	GLA08	20-40 KM Aerosol Layer Quality Level Flag																		
al_htgs	i20_aer_lay_uf	3	GLA08	20-40 KM Aerosol Layer Use Flag																		
al_htgs	i4_aer_lay_qf	5	GLA08	Below 20 KM Aerosol Layer Quality Level Flag																		
al_htgs	i4_aer_lay_uf	5	GLA08	Below 20 KM Aerosol Layer Use Flag																		
latlon	d1_prof_loc	2	GLA08	Profile Location	0																	
off_nadir_pt	d1_off_nad_pt	3	GLA08	PAD Controlled Pointing Vector	0																	
off_nadir_pt	i1_off_nad_qf	1	GLA08	Controlled Pointing Vector Quality Flag	0																	
pbl_htgs	d4_pbl_grd_det	1	GLA08	Ground Detection for Low Res PBL												0	i	i				
pbl_htgs	d4_pbl_ht	1	GLA08	Low Resolution Boundary Layer Height												0	i	i				
pbl_htgs	d5_pbl_grd_det	1	GLA08	Ground Detection for High Res PBL												0						
pbl_htgs	d5_pbl_ht	1	GLA08	High Resolution Boundary Layer Height												0						
pbl_htgs	i4_pbl_ht_ccf	1	GLA08	Low Resolution Clear/Cloudy PBL Flag												0	i	i				
pbl_htgs	i4_pbl_ht_qf	1	GLA08	Low Resolution Boundary Height Quality Level Flag												0	i	i				
pbl_htgs	i4_pbl_ht_uf	1	GLA08	Low Resolution Boundary Height Use Flag												0	i	i				
pbl_htgs	i5_pbl_ht_ccf	1	GLA08	High Resolution Clear/Cloudy PBL Flag												0						
pbl_htgs	i5_pbl_ht_qf	1	GLA08	High Resolution Boundary Layer Height Quality Level Flag												0						
pbl_htgs	i5_pbl_ht_uf	1	GLA08	High Resolution Boundary Layer Height Use Flag												0						
time	d1_time	1	GLA08	Time of First Sample																		
		1	GLA08	Boundary Layer Height Record Index																		
atm_range	d40_elev_pr	1	GLA09	Surface Elevation - Peak of Return																		
atm_range	d40_elev_tr	1	GLA09	Surface Elevation - Threshold of Return																		
atm_range	d40_thr_xg	1	GLA09	Threshold Crossing																		
cloud_htgs	d1_cld_bot	10	GLA09	Medium Resolution Cloud Bottom												0	i	i				
cloud_htgs	d1_cld_grd_det	1	GLA09	Medium Resolution Ground Detection												0	i	i				
cloud_htgs	d1_cld_top	10	GLA09	Medium Resolution Cloud Top												0	i	i				
cloud_htgs	d4_cld_bot	10	GLA09	Low Resolution Cloud Bottom												0	i	i				
cloud_htgs	d4_cld_grd_det	1	GLA09	Low Resolution Ground Detection												0	i	i				
cloud_htgs	d4_cld_top	10	GLA09	Low Resolution Cloud Top												0	i	i				
cloud_htgs	d40_cld_bot	1	GLA09	Full Resolution Cloud Bottom												0						
cloud_htgs	d40_cld_grd_det	1	GLA09	Full Resolution Cloud Ground Detection												0						
cloud_htgs	d40_cld_top	1	GLA09	Full Resolution Cloud Top												0						
cloud_htgs	d5_cld_bot	10	GLA09	High Resolution Cloud Bottom												0	i					
cloud_htgs	d5_cld_grd_det	1	GLA09	High Resolution Ground Detection												0	i					
cloud_htgs	d5_cld_top	10	GLA09	High Resolution Cloud Top												0	i					
cloud_htgs	i1_cld_lay_af	1	GLA09	Medium Resolution Available Flag												0	i	i				
cloud_htgs	i1_cld_lay_qf	10	GLA09	Medium Resolution Cloud Quality Flag												0	i	i				
cloud_htgs	i1_cld_lay_uf	10	GLA09	Medium Resolution Cloud Use Flag												0	i	i				
cloud_htgs	i4_cld_lay_af	1	GLA09	Low Resolution Available Flag												0	i	i				
cloud_htgs	i4_cld_lay_qf	10	GLA09	Low Resolution Cloud Layer Quality Flag												0	i	i				
cloud_htgs	i4_cld_lay_uf	10	GLA09	Low Resolution Cloud Layer Use Flag												0	i	i				
cloud_htgs	i40_cld_lay_af	1	GLA09	Full Resolution Available Flag												0						
cloud_htgs	i40_cld_lay_qf	1	GLA09	Full Resolution Cloud Quality Flag												0						
cloud_htgs	i40_cld_lay_uf	1	GLA09	Full Resolution Cloud Use Flag												0						
cloud_htgs	i5_cld_lay_af	1	GLA09	High Resolution Available Flag												0	i					
cloud_htgs	i5_cld_lay_qf	10	GLA09	High Resolution Cloud Quality Flag												0	i					
cloud_htgs	i5_cld_lay_uf	10	GLA09	High Resolution Cloud Use Flag												0	i					
latlon	d1_prof_loc	2	GLA09	Profile Location	0													i	i			
off_nadir_pt	d1_off_nad_pt	3	GLA09	PAD Controlled Pointing Vector	0																	
off_nadir_pt	i1_off_nad_qf	1	GLA09	Controlled Pointing Vector Quality Flag	0																	
time	d1_time	1	GLA09	Time of First Sample														i	i			
		1	GLA09	Cloud Height Record Index																		
al_cs	d4_aer_bs_cs	534	GLA10	Aerosol Backscatter Cross Section Data																		
al_cs	d4_aer_ext_cs	534	GLA10	Aerosol Extinction Cross Section Data																		
al_cs	d4_aer_sval	9	GLA10	Aerosol S Values																		
al_cs	d4_pbl_aer_bot	9	GLA10	Low Resolution Aerosol Layer Bottom (subset)																		
al_cs	d4_pbl_aer_top	9	GLA10	Low Resolution Aerosol Layer Top (subset)																		
al_cs	i4_aer_bs_qf	9	GLA10	Aerosol Backscatter Layer Quality Flag																		
al_cs	i4_aer_bs_uf	9	GLA10	Aerosol Backscatter Layer Use Flag																		
al_cs	i4_aer_ext_qf	9	GLA10	Aerosol Extinction Layer Quality Flag																		
al_cs	i4_aer_ext_uf	9	GLA10	Aerosol Extinction Layer Use Flag																		
cloud_cs	d1_cld_bot_sub	10	GLA10	Medium Resolution Cloud Bottom (subset)																		
cloud_cs	d1_cld_bs_cs	280	GLA10	Cloud 532 nm Backscatter Cross Section Data																		
cloud_cs	d1_cld_ext_cs	280	GLA10	Cloud Extinction Cross Section Data																		
cloud_cs	d1_cld_grd_sub	1	GLA10	Medium Resolution Ground Detection (subset)																		
cloud_cs	d1_cld_sval	10	GLA10	Cloud S values																		
cloud_cs	d1_cld_top_sub	10	GLA10	Medium Resolution Cloud Top (subset)																		
cloud_cs	i1_cld_bs_qf	10	GLA10	Cloud 532 nm Backscatter Layer Quality Flag																		
cloud_cs	i1_cld_bs_uf	10	GLA10	Cloud 532 nm Backscatter Layer Use Flag																		
cloud_cs	i1_cld_ext_qf	10	GLA10	Cloud Extinction Layer Quality Flag																		
cloud_cs	i1_cld_ext_uf	10	GLA10	Cloud Extinction Layer Use Flag																		
latlon	d1_prof_loc	2	GLA10	Profile Location	0																	
off_nadir_pt	d1_off_nad_pt	3	GLA10	PAD Controlled Pointing Vector	0																	
off_nadir_pt	i1_off_nad_qf	1	GLA10	Controlled Pointing Vector Quality Flag	0																	
pbl_htgs	d4_pbl_grd_det	1	GLA10	Low Resolution Aerosol Layer Ground Detection												0						
time	d1_time	1	GLA10	Time of First Sample																		
		1	GLA10	Aerosol Record Index																		

# DRAFT

**Table 12.**

Structure Chart Variable	PDL Variables	Dim	File ID	File Element	A_intrp_geoloc	A_interp_met	A_mbes	A_cal_colis	A_ir_bsbs	A_g_bsbs	A_ls_qa_stas	A_avg_bsbs	A_cld_lays	A_pbl_lay	A_aer_lays	A_ls_qa_stats	A_aer_opt_prop	A_cld_opt_prop	A_tp_qa_stats	A_qa_stats	A_pbl_write	A_wrapup	
al_od	d4_aer_msf	9	GLA11	Aerosol Multiple Scattering Coefficient													o	-					
al_od	d4_aer_od	8	GLA11	Aerosol Optical Depth													o	-					
al_od	d4_elv_aer_bot	8	GLA11	Low Resolution Aerosol Layer Bottom (subset)													o	-					
al_od	d4_elv_aer_top	8	GLA11	Low Resolution Aerosol Layer Top (subset)													o	-					
al_od	d4_pbl_od	1	GLA11	Boundary Layer Optical Depth													o	-					
al_od	i4_aer_od_qf	8	GLA11	Aerosol Optical Depth Quality Flag													o	-					
al_od	i4_aer_od_pf	8	GLA11	Aerosol Optical Depth Use Flag													o	-					
al_od	i4_pbl_od_qf	1	GLA11	Boundary Layer Optical Depth Quality Flag													o	-					
al_od	i4_pbl_od_pf	1	GLA11	Boundary Layer Optical Depth Use Flag													o	-					
cloud_od	d1_cld_bot_sub	10	GLA11	Medium Resolution Cloud Bottom (subset)														o					
cloud_od	d1_cld_grd_sub	1	GLA11	Medium Resolution Ground Detection (subset)														o					
cloud_od	d1_cld_msf	10	GLA11	Cloud Multiple Scattering Coefficient														o					
cloud_od	d1_cld_od	10	GLA11	Cloud Optical Depth														o					
cloud_od	d1_cld_top_sub	10	GLA11	Medium Resolution Cloud Top (subset)														o					
cloud_od	i1_cld_ms_wf	1	GLA11	Multiple Scattering Warning Flag														o					
cloud_od	i1_cld_od_qf	10	GLA11	Cloud Optical Depth Quality Flag														o					
cloud_od	i1_cld_od_pf	10	GLA11	Cloud Optical Depth Use Flag														o					
latlon	d1_prof_loc	2	GLA11	Profile Location													o						
off_nadir_pt	d1_off_nad_pt	3	GLA11	PAD Controlled Pointing Vector													o						
off_nadir_pt	i1_off_nad_qf	1	GLA11	Controlled Pointing Vector Quality Flag													o						
pbl_htgs	d4_pbl_grd_det	1	GLA11	Ground Detection for Low Res PBL													o						
pbl_htgs	d4_pbl_ht	1	GLA11	Low Resolution Boundary Layer Height													o						
time	d1_time	1	GLA11	Time of First Sample																			
			1	GLA11	Optical Depth Record Index																		
1064_bs_atmos_ctrl	i1_irbs_ctrl	1	internal	Control													i						
1064_bsQA	t_irbsQA		internal	QA												o	i						
1sec_bs_avgs	d1_g_avg_bsbs	534	internal	532 nm 1 sec backscatter cross section averages													o	i					
4sec_bs_avgs	d4_g_avg_bsbs	534	internal	532 nm 4 sec backscatter cross section averages													o	i					
532_bs_atmos_ctrl	i1_gbs_ctrl	1	internal	Control													i						
532_bsQA	t_gbsQA		internal	QA													o	i					
al_atmos_ctrl	i1_al_ctrl	1	internal	Control															i				
alQA	t_alQA		internal	QA														o	i				
ao_atmos_ctrl	i1_ao_ctrl	1	internal	Control															i				
aoQA	t_aoQA		internal	QA														o	i				
atm_met_data	d1_met_only	3,14	internal	Met data at 1 sec												x							
av_atmos_ctrl	i1_av_ctrl	1	internal	Control														i					
avQA	t_avQA		internal	QA													o	i					
bs_QA_ctrl	i1_bsQA_ctrl	1	internal	Control														i					
bsQA	t_bsQA		internal	QA													o	i					
cc_atmos_ctrl	i1_cc_ctrl	1	internal	Control													i						
ccQA	t_ccQA		internal	QA													o	i					
cl_atmos_ctrl	i1_cl_ctrl	1	internal	Control														i					
clQA	t_clQA		internal	QA													o	i					
co_atmos_ctrl	i1_co_ctrl	1	internal	Control														i					
coQA	t_coQA		internal	QA														o	i				
end_data			internal	wrapup data															i				
file_ctrl	i_file_ctrl	1	internal	Control																			
ig_atmos_ctrl	i1_ig_ctrl	1	internal	Control												i							
igQA	t_igQA		internal	QA												o	i						
im_atmos_ctrl	i1_im_ctrl	1	internal	Control												i							
imQA	t_imQA		internal	QA												o	i						
lh_QA_ctrl	i1_lhQA_ctrl	1	internal	Control														i					
lhQA	t_lhQA		internal	QA													o	i					
mb_atmos_ctrl	i1_mb_ctrl	1	internal	Control												i							
mbQA	t_mbQA		internal	QA												o	i						
met_at_1sec	d1_met_data	3,14	internal	Met/Std Atm data at 1 sec												o	i			i	i		
met_data1	met1		internal	Met data from file 1												x							
met_data2	met2		internal	Met data from file 2												x							
met_locs			internal	lat/lons of met data												x							
met_luns	i1_met_lun1	1	internal	Met file 1 logical unit number													i						
met_luns	i1_met_lun2	1	internal	Met file 2 logical unit number													i						
num_params	atm_met_parm	1	internal	number of met parameters needed												x							
op_QA_ctrl	i1_opQA_ctrl	1	internal	Control															i				
opQA	t_opQA		internal	QA														o	i				
pl_atmos_ctrl	i1_pl_ctrl	1	internal	Control														i					
plQA	t_plQA		internal	QA														o	i				
POD	d1_POD	3	internal	POD data												i							
POD_pos_vect	d1_POD_pos_v	3	internal	POD position vector												x							
pw_atmos_ctrl	i1_pw_ctrl	1	internal	Control															i				
QA_atmos_ctrl	i1_QA_ctrl	1	internal	Control															i				
std_atm_lun	i1_sa_lun	1	internal	Std Atm file logical unit number												i							
tQA	t_tQA		internal	QA														o					
wr_atmos_ctrl	i1_wr_ctrl	1	internal	Control														i					
532_1064_bs_calib_coeff	532_bs_calib_coeff + 1064_bs_calib_coeff															o							
532_1064_M_bs_cs	532_M_bs_cs + 1064_M_bs_cs															o	i						
bs_avgs	1sec_bs_avgs + 4sec_bs_avgs																o	i					
GLA07_data	1064_bs_calib_coeff + 1064_bs_cs + 1064_LIDAR_data + 532_bs_calib_coeff + 532_bs_cs + 532_LIDAR_data + latlon + off_nadir_pt + time + atm_range																		i				
GLA08_data	al_hgts + pbl_hgts + off_nadir_pt + latlon + time																		i				
GLA09_data	cloud_hgts + off_nadir_pt + latlon + time + atm_range																		i				
GLA10_data	al_cs + cloud_cs + off_nadir_pt + latlon + time																		i				
GLA11_data	al_od + cloud_od + off_nadir_pt + latlon + time																		i				
layer_hgts	cloud_hgts + pbl_hgts + al_hgts																		i				
LIDAR_data	532_LIDAR_data + 1064_LIDAR_data															i							

# DRAFT

## 16.4 Level 1B and 2 Elevation

**Table 13.**

SC Var	PDL Var	File ID	File Element	E_I ntrp PO D	E_Mer geP AD	E_g etTi des	E_Ge tGeo id	E_Ge tTro p	E_Cal cSt dIR	E_Cal cLd IR	E_Cal cOc IR	E_Cal cSi R	E_Cal clsI R	E_Cal cSt dSp t	E_Cal cEl vQ A	E_Cal cRe fl	E_CrL 1B QA	E_Cal cRe gSp tR	E_Cre ateL2 QA
		GLA05	Waveform Record Index																
std_range_corr	d_stdRngOff	GLA05	Standard Range Offset						i										
ref_range	d_refRng	GLA05	Reference Range						i					i					
		GLA05	WF Parameters - Land or Ocean							i	i								
		GLA05	WF Parameters, Ice Sheet									i	i						
		GLA05	Range Offset to First Threshold Crossing																
		GLA05	WF Parameter Sigma - Land, Ocean																
		GLA05	WF Parameter Sigmas - Ice Sheet																
		GLA05	Chi Square - Land, Ocean																
		GLA05	WF Fit Sigma - Ice Sheet																
		GLA05	Chi Square - Ice Sheet																
		GLA05	WF Fit Sigma - Land, Ocean																
		GLA05	Rank of Significant Peaks - Land, Ocean																
		GLA05	Max Amp of the Raw Waveform																
		GLA05	Area for Signal Return of the Raw WF																
		GLA05	Skewness and Curtosis of Raw WF Signal Return																
		GLA05	Percent of Saturated Signal From Raw WF																
		GLA05	Beginning and Ending of Signal From Raw WF																
		GLA05	Range Offset to Centroid of Raw WF Signal																
		GLA05	Peak Amplitude of Smooth WF																
		GLA05	Range Offset to Centroid from Smooth WF																
		GLA05	Number of Peaks of the Smooth WF																
		GLA05	Beginning and End of Signal from Smooth WF																
		GLA05	Rank of Significant Peaks - Ice Sheet																
		GLA05	On-board Error Flags																
		GLA05	Transmit Pulse Characterization																
		GLA05	Noise Level of WF																
		GLA05	1064 nm Programmable Gain Amplifier Setting																
		GLA05	Energy Transmit																

# DRAFT

		GLA05	Waveform Quality Flag													
		GLA05	Frame Use Flag													
surf_type	r_surfTyp	GLA05	Surface Type													
		GLA05	Instrument State													
		GLA05	Time of First Laser Pulse	i	i	i		i								
		GLA05	PAD Pointing Vector													
		GLA05	POD Fixed Position Vector													
		GLA05	Spot 1 Coordinate Data													
		GLA05	Laser Shot Time Deltas													
		GLA05	Delta Spot Coordinates													
		GLA05	POD 40 per Second Quality Flag													
		GLA05	PAD at 40 per Second Quality Flag													
		GLA05	Orbit Number													
spot3dStdUncor	d_spotLat d_spotLon D_spotElev	GLA05	Std Spot Loc			i	i	i								
***** *****	Extra Variables															
			POD From CSR (Extra Variable)	i												
			PAD From CSR (Extra Variable)		i											
		GLA06	Elevation Record Index													
std_range_corr	d_stdRngOff	GLA06	Standard Range Offset					o				i			i	
ref_range	d_refRng	GLA06	Reference Range												i	
		GLA06	Elevation Quality/Use Flag													
seaice_instr_rng	d_siRngOff	GLA06	Sea Ice Range Correction Offset								o					
ocean_instr_rng	d_ocRngOff	GLA06	Ocean Range Correction Offset								o					
land_instr_rng	d_ldRngOff	GLA06	Land Range Correction Offset							o						
icesheet_instr_r ng	d_icRngOff	GLA06	Ice Sheet Range Correction Offset									o				
		GLA06	Peak Amplitude of Smooth WF													
		GLA06	Range Offset to Centroid from Smooth WF													
		GLA06	Number of Peaks of the Smooth WF													
		GLA06	Beginning and End of Signal from Smooth WF													
		GLA06	Orientation of Pulse													
		GLA06	Sigma of Elevation													
		GLA06	DEM Elevation												i	
		GLA06	Reflectance Correction, Atmosphere													
		GLA06	Reflectance Correction, Solar Angle													

# DRAFT

		GLA06	Reflectance Correction, Laser Pointing																		
		GLA06	Reflectance Correction, from WF Parameterization																		
reflectance	r_refl	GLA06	Reflectance																<b>o</b>		
		GLA06	Surface Slope																		
		GLA06	Goodness of Fit, Roughness																		
		GLA06	Surface Roughness Quality Flag																		
		GLA06	Surface Roughness																		
		GLA06	Cloud Coverage Flag																		
atm_quality_flag	i_atmQF	GLA06	Meteorological Data Quality Flag															<b>o</b>			
		GLA06	Elevation Quality																		
surf_type	r_surfTyp	GLA06	Surface Type																	<b>i</b>	
		GLA06	Instrument State																		
		GLA06	Geo Properties Flag																		
		GLA06	Elevation Corrections Quality Flag																		
geoid_hgt	r_gdHt	GLA06	Geoid					<b>o</b>													
ocean_tide_elev	r_ocElv	GLA06	Ocean Tide Elevation			<b>o</b>											<b>i</b>			<b>i</b>	
earth_tide_elev	r_erElv	GLA06	Earth Tide Elevation			<b>o</b>											<b>i</b>			<b>i</b>	
		GLA06	Pulse Atmospheric Dispersion Correction																		
load_tide_elev	r_ldElv	GLA06	Load Tide Elevation			<b>o</b>											<b>i</b>			<b>i</b>	
pole_tide_elev	r_poElv	GLA06	Pole Tide Elevation			<b>o</b>											<b>i</b>			<b>i</b>	
trop_corr	r_dTrop	GLA06	Range Correction, Dry Troposphere					<b>o</b>									<b>i</b>			<b>i</b>	
trop_corr	r_wTrop	GLA06	Range Correction, Wet Troposphere					<b>o</b>									<b>i</b>			<b>i</b>	
PAD_pointing_vect	d_lasITRF	GLA06	PAD Pointing Vector		<b>o</b>												<b>i</b>			<b>i</b>	
		GLA06	Local Azimuth																		
std_corr_spot_1oc	d_corSpLoc d_corSpElv	GLA06	Spot Coordinate Data														<b>o</b>				
		GLA06	Orbit Number																		
POD_position_vect	d_scITRF	GLA06	POD Fixed Position Vector	<b>o</b>													<b>i</b>			<b>i</b>	
		GLA06	Solar Incidence Angle																		
		GLA06	Laser Shot Time Deltas																		
time	d_time	GLA06	Time of First Laser Pulse																	<b>i</b>	
		GLA06	Spot Coordinate Deltas																		
		GLA06	POD 40 per Second Quality Flag																		
		GLA06	PAD at 40 per Second Quality Flag																		
		GLA12	Ice Sheet Elevation Record Index																		
L2icesheet_rng_cor	d_icRngOff	GLA12	Ice Sheet Range Correction Offset																<b>o</b>		

# DRAFT

		GLA12	Ice Sheet Elevation Quality Flag																
		GLA12	Sigma of Elevation																
std_range	d_stdRngOff	GLA12	Standard Range Offset																
		GLA12	Number of Peaks of the Smooth WF																
		GLA12	Orientation of Pulse																
		GLA12	DEM Elevation																
ref_range	d_refRng	GLA12	Reference Range																
		GLA12	Reflectance																
		GLA12	Ice Sheet Corrected Roughness																
		GLA12	Ice Sheet Roughness Quality Flag																
		GLA12	Goodness of Fit of the Ice Sheet Surface Roughness																
		GLA12	Surface Slope																
trop_corr	r_wTrop	GLA12	Range Correction, Dry Troposphere																
ocean_tide_elev	r_ocElv	GLA12	Ocean Tide Elevation																
earth_tide_elev	r_erElv	GLA12	Earth Tide Elevation																
pole_tide_elev	r_poElv	GLA12	Pole Tide Elevation																
		GLA12	Pulse Atmospheric Dispersion Correction																
geoid_hgt	r_gdHt	GLA12	Geoid																
load_tide_elev	r_ldElv	GLA12	Load Tide Elevation																
trop_corr	r_dTrop	GLA12	Range Correction, Wet Troposphere																
icesheet_spot_1	d_icSpLoc	GLA12	Spot 1 Coordinate Data																<b>0</b>
oc	d_icSpElv	GLA12	Solar Incidence Angle																
		GLA12	Orbit Number																
PAD_pointing_vect	d_lasITRF	GLA12	PAD Pointing Vector		<b>0</b>														
		GLA12	Laser Shot Time Deltas																
time	d_time	GLA12	Time of First Laser Pulse																
		GLA12	Deltas to Spot 1 Coordinate Data																
		GLA12	POD 40 per Second Quality Flag																
		GLA12	PAD at 40 per Second Quality Flag																
		GLA12	Cloud Coverage Flag																
		GLA12	Instrument State																
		GLA12	Geo Properties Flag																
		GLA12	Meteorological Data Quality Flag																
		GLA12	Elevation Corrections Quality Flag																
*****	<b>Extra Variables</b>																		
POD_position_vect	d_scITRF		POD Fixed Position Vector (Extra Variable)	<b>0</b>															

# DRAFT

		GLA13	Sea Ice Record Index											
		GLA13	Sea Ice Elevation Quality Flag											
L2seacie_rng_c or	d_siRngOff	GLA13	Sea Ice Range Correction Offset											<b>0</b>
		GLA13	Elevation Correction to the Last Peak											
		GLA13	Range Offset to First Threshold Crossing											
std_range	d_stdRng	GLA13	Standard Range Offset											
		GLA13	Max Amp of the Raw Waveform											
		GLA13	Area for Signal Return of the Raw WF											
		GLA13	Skewness and Curtosis of Raw WF Signal Return											
		GLA13	Percent of Saturated Signal From Raw WF											
		GLA13	Beginning and Ending of Signal From Raw WF											
		GLA13	Range Offset to Centroid of Raw WF Signal											
		GLA13	Number of Peaks of the Smooth WF											
		GLA13	Orientation of Pulse											
		GLA13	Sigma of Elevation											
		GLA13	DEM Elevation											
ref_range	d_refRng	GLA13	Reference Range											
		GLA13	Reflectance											
		GLA13	Sea Ice Roughness											
		GLA13	Sea Ice Roughness Quality Flag											
		GLA13	Goodnes of Fit of the Sea Ice Surface Roughness											
trop_corr	r_dTrop	GLA13	Range Correction, Dry Troposphere											
ocean_tide_elev	r_ocElv	GLA13	Ocean Tide Elevation											
		GLA13	Pulse Atmospheric Dispersion Correction											
pole_tide_elev	r_poElv	GLA13	Pole Tide Elevation											
load_tide_elev	r_ldElv	GLA13	Load Tide Elevation											
earth_tide_elev	r_erElv	GLA13	Earth Tide Elevation											
trop_corr	r_wTrop	GLA13	Range Correction, Wet Troposphere											
geoid_hgt	r_gdHt	GLA13	Geoid											
		GLA13	Solar Incidence Angle											
		GLA13	Orbit Number											
PAD_pointing_vect	d_lasITRF	GLA13	PAD Pointing Vector		<b>0</b>									
seacie_spot_loc	d_siSpLoc d_icSpElv	GLA13	Spot 1 Coordinate Data											<b>0</b>
		GLA13	Laser Shot Time Deltas											

# DRAFT

		GLA13	Time of First Laser Pulse																
		GLA13	Deltas to Spot 1 Coordinate Data																
		GLA13	POD 40 per Second Quality Flag																
		GLA13	PAD at 40 per Second Quality Flag																
		GLA13	Ice Berg Second Hit																
		GLA13	Ice Berg Corrected Elevation																
		GLA13	Ice Berg Data Quality																
		GLA13	Cloud Coverage Flag																
		GLA13	Instrument State																
		GLA13	Geo Properties Flag																
		GLA13	Meteorological Data Quality Flag																
		GLA13	Elevation Corrections Quality Flag																
***** *****	<b>Extra Variables</b>																		
POD_position_vect	d_scITRF		POD Fixed Position Vector (Extra Variable)	<b>o</b>															
		GLA14	Land/Canopy Record Index																
		GLA14	Detected Surface Elevation Quality Flag																
		GLA14	Lowest Elevation																
		GLA14	Highest Elevation																
		GLA14	Lowest Elevation Above Last Peak																
		GLA14	Highest Elevation of Last Peak																
L2land_rng_cor	d_ldRngOff	GLA14	Land Range Correction Offset																<b>o</b>
		GLA14	Mean Range Correction Offset																
std_range_cor	d_stdRngOff	GLA14	Standard Range Offset																
		GLA14	Range Offset to Centroid of Raw WF Signal																
		GLA14	Number of Peaks of the Smooth WF																
		GLA14	Land Elevation Quality Flag																
		GLA14	Orientation of Pulse																
		GLA14	Sigma of Elevation																
		GLA14	DEM Elevation																
ref_range	d_refRng	GLA14	Reference Range																
		GLA14	Mean Elevation Quality Flag																
		GLA14	Mean Elevation																
		GLA14	Gaussian Fit Position of Each Peak Offset, Land																
		GLA14	Gaussian Fit RMS Width of each peak, Land																
		GLA14	Range Offset Mean Detection Above Last Peak, Land																

# DRAFT

		GLA14	Range Offset Mean Detection of Last Peak, Land																				
		GLA14	Number of Peaks																				
		GLA14	Elevation Variance Quality Flag																				
		GLA14	Elevation Variance of Last Peak																				
		GLA14	Elevation Variance Above Last Peak																				
		GLA14	Elevation Variance																				
		GLA14	Energy Transmit																				
		GLA14	Energy (Ratio of Last Peak to Total Area)																				
		GLA14	Energy Per Peak																				
		GLA14	Cloud Coverage Flag																				
surf_type	r_surfTyp	GLA14	Surface Type																				
		GLA14	Instrument State																				
		GLA14	Geo Properties Flag																				
		GLA14	Meteorological Data Quality Flag																				
		GLA14	Elevation Corrections Quality Flag																				
pole_tide_elev	r_poElv	GLA14	Pole Tide Elevation																				
earth_tide_elev	r_erElv	GLA14	Earth Tide Elevation																				
load_tide_elev	r_ldElv	GLA14	Load Tide Elevation																				
ocean_tide_elev	r_ocElv	GLA14	Ocean Tide Elevation																				
trop_corr	r_dTrop	GLA14	Range Correction, Dry Troposphere																				
trop_corr	r_wTrop	GLA14	Range Correction, Wet Troposphere																				
geoid_hgt	r_gdHt	GLA14	Geoid																				
		GLA14	Solar Incidence Angle																				
		GLA14	Orbit Number																				
PAD_pointing_vect	d_lasITRF	GLA14	PAD Pointing Vector		<b>0</b>																		
land_spot_loc	d_ldSpLoc, d_ldSpElv	GLA14	Spot 1 Coordinate Data																		<b>0</b>		
		GLA14	Laser Shot Time Deltas																				
		GLA14	Time of First Laser Pulse																				
		GLA14	Deltas to Spot 1 Coordinate Data																				
		GLA14	POD 40 per Second Quality Flag																				
		GLA14	PAD at 40 per Second Quality Flag																				
		GLA14	Reflectance																				
***** *****	Extra Variables																						
POD_position_vect	d_scITRF		POD Fixed Position Vector (Extra Variable)	<b>0</b>																			
		GLA15	Ocean Elevation Record Index																				

# DRAFT

		GLA15	Ocean Elevation Quality Flag																
L2ocean_rng_c or	d_ocRngOff	GLA15	Ocean Range Correction Offset																<b>0</b>
std_range	d_stdRng	GLA15	Standard Range Offset																
		GLA15	Orientation of Pulse																
		GLA15	Sigma of Elevation																
		GLA15	DEM Elevation																
ref_range	d_refRng	GLA15	Reference Range																
		GLA15	Reflectance																
		GLA15	Ocean Roughness Quality Flag																
		GLA15	Ocean Corrected Roughness																
		GLA15	Goodness of Fit of the Ocean Surface Roughness																
		GLA15	Pulse Atmospheric Dispersion Correction																
trop_corr	r_dTrop	GLA15	Range Correction, Dry Troposphere																
ocean_tide_elev	r_ocElv	GLA15	Ocean Tide Elevation																
earth_tide_elev	r_erElv	GLA15	Earth Tide Elevation																
load_tide_elev	r_ldElv	GLA15	Load Tide Elevation																
pole_tide_elev	r_poElv	GLA15	Pole Tide Elevation																
trop_corr	r_wTrop	GLA15	Range Correction, Wet Troposphere																
geoid_hgt	r_gdHt	GLA15	Geoid																
		GLA15	Orbit Number																
		GLA15	Solar Incidence Angle																
		GLA15	POD 40 per Second Quality Flag																
		GLA15	PAD at 40 per Second Quality Flag																
		GLA15	Laser Shot Time Deltas																
PAD_pointing_vect	d_lasITRF	GLA15	PAD Pointing Vector		<b>0</b>														
ocean_spot_loc	d_ocSpLoc, d_ocSpElv	GLA15	Spot 1 Coordinate Data																<b>0</b>
		GLA15	Time of First Laser Pulse																
		GLA15	Deltas to Spot 1 Coordinate Data																
		GLA15	Cloud Coverage Flag																
		GLA15	Instrument State																
		GLA15	Geo Properties Flag																
		GLA15	Meteorological Data Quality Flag																
		GLA15	Elevation Corrections Quality Flag																
POD_position_vect	d_scITRF	GLA15	POD Fixed Position Vector	<b>0</b>															

# DRAFT

## 17 Appendix C

## 18 Data Files and Formats

## 19 C/Fortran/Sub-ATBD Interface

First, some definitions: (1) algorithm data (units for algorithm use) are that data which are in a form most favorable for display and calculation; (2) product data (units for I/O) are that data which are in a form most favorable for machine independence and storage efficiency.

A simplified, data-specific description of the processing flow from input SCF file to output SCF file follows:

- (1) Data are stored in GLAS SCF files in a product form.
- (2) The GLAS\_Exec read routine will call a product-specific C routine to read a record of data into a C product structure.
- (3) The f90 product structure will be converted (method TBD) into an f90 algorithm structure. The conversion is a simple data type and unit transformation – there is a one-to-one correspondence between the variables described in each product definition and the f90 algorithm structure.
- (4) The resultant f90 algorithm structure is passed as an argument back to the calling Fortran 90 program via a F90 global structure (defined in a module).
- (5) All pass-thru data from input product(s) are copied to the output product.
- (6) In a reprocessing scenario, when using same-type input and output products, data are copied from input product to output product.
- (7) Required input and output data structures are accessed by the appropriate Subsystem Manager.
- (8) Data which need further conversion in order to be usable by the sub-ATBDs are converted and placed in local variables. (This includes such conversions as unpacking flags and adding offsets or reference values).
- (9) The manager passes (via an argument list) data to/from each sub-ATBD. Sub-ATBDs only have access to the data they need, not the whole data structure. Additionally, data are passed primarily from the output structure. Those data not available from the output structure are passed from the input structure. This method of passing data, along with the processes described in steps 5 and 6, allow the Sub-ATBDs to be coded without regard to processing or reprocessing scenarios.
- (10) Data are processed by the appropriate Sub-ATBDs.
- (11) Local variables which need further conversion in order to be consistent with the output structure are converted and placed in output structure. (This includes such conversions as packing flags and subtracting offsets or reference values).
- (11) When a product record is complete, GLAS\_Exec will call a product-specific C routine to write the record of data.
- (10) The algorithm f90 structure will be converted (method TBD) into a product f90 structure. The conversion is a simple data type and unit transformation – there is a one-to-one correspondence between the variables described in each product definition and the f90 algorithm structure.
- (11) The product f90 structure will be passed as an argument to an identically-shaped C product structure and written by a product-specific C routine to the output file.

The benefit of this method is that the I/O and scaling routines are very language-independent and that scaling/unscaling is handled inside the I/O routines so that both internal and external programmers can simply call the I/O routine and end up with a structure of algorithm data.

## 20 Fortran Subroutine Interface Mechanism

Subsystems and Managers will use f90 modules to **define** data types. Modules will **not** be used to create global data except in special circumstances dictated by GLAS\_Exec. Structures will be defined with the *type-endtype* construct and variables will be defined with the same type of constructs used by *kindsmod*. The benefits of this are that even though variables are passed from Manager to ATBD via the argument list, the use of modules minimizes the risk of mismatched data types between the Manager and ATBD. We get the benefits of :

# DRAFT

- Guaranteeing local variables via the argument list construct
- Ability to declare *INTENT(IN)* and *INTENT(OUT)*
- Ability to change the variable type or dimensions in one place and have this change automatically propagate to all routines which use the variable.
- Less chance of errors since data types are defined in only place.

## 21 Library Definitions and Contents

Libraries will be the key to making GLAS\_Exec and related I-SIPS software consistent and maintainable. This section will identify each library and the contents thereof:

### *libcio.a – Generic C routines for reading and writing data.*

cappend.c positions file pointer to EOF on opened file.  
cclose.c closes and open file.  
cnlines.c counts number of lines in ASCII file.  
cfsiz.c counts number of bytes in file.  
copen.c opens a file for specified activity.  
cread.c reads bytes from a file.  
crewind.c rewinds an open file.  
cseek.c positions file pointer on opened file  
cwrite.c writes bytes to a file.  
vers\_cio\_mod.f90 Version information for library

### *libio.a – C and F90 routines for reading and/or writing each GLA/ANC file.*

read\_glaxx.c reads GLAXX data and returns PRODUCT structures.  
write\_glaxx.c writes GLAXX PRODUCT structures.  
glaxx\_mod.f90 GLAXX PRODUCT structures.  
aglaxx\_mod.f90 GLAXX ALGORITHM structures.  
glaxx\_p2a\_conv.f90 Converts GLAXX PRODUCT data to ALGORITHM data.  
glaxx\_a2p\_conv.f90 Converts GLAXX ALGORITHM data to PRODUCT data.  
read\_ancxx.c reads ANCXX data and returns PRODUCT structures.  
write\_ancxx.c writes ANCXX PRODUCT structures.  
ancxx\_mod.f90 ANCXX PRODUCT structures.  
aancxx\_mod.f90 ANCXX ALGORITHM structures.  
ancxx\_p2a\_conv.f90 Converts ANCXX PRODUCT data to ALGORITHM data.  
ancxx\_a2p\_conv.f90 Converts ANCXX ALGORITHM data to PRODUCT data.  
vers\_io\_mod.f90 Version information for library

### *lib\_cntrl.a f90 routines for control file and interface handling*

center{text}\_mod.f90 Centers string on 80 column line.  
doubleline\_mod.f90 Prints 80 column double line (=)  
exec\_flag\_mod.f90 Module which defines exec\_flags  
finfo\_mod.f90 Module which defines file control structures  
getans.f90 Gets single-key input from user  
keyval\_mod.f90 Defines keyword-value data type  
multimenu\_mod.f90 Gets user choices from a multiple-option menu  
parse\_keyval\_mod.f90 Parses keyword-value from a string  
singleline\_mod.f90 Prints 80 column single line (-)  
strtrim.f90 Strips spaces from a string.  
tolower.f90 Converts string to lower case  
toupper.f90 Converts string to upper case  
writebanner\_mod.f90 Writes informative banner  
vers\_cntrl\_mod.f90 Version information for library

### *lib\_glaserr Error handling routines*

# DRAFT

(TBD)

*lib\_platform.a platform-specific routines*

kinds\_mod.f90 Kinds module

## 22 Control File Format

The GLAS Control File will be dynamically generated by the Data Management scheduler and redirected into the GLAS\_Exec process. The Data Management system will have a database of “recipes” which are used to create unique control files for pre-defined operational scenarios. The standard method of control will be the control file. It may be generated by the database or by hand. The control file is passed as a command line argument to GLAS\_Exec. The secondary method of control occurs when GLAS\_Exec detects that there is no control file argument passed on the command line. When no file is specified, GLAS\_Exec runs through an interactive text-based interface which has the same options that could be specified by the control file. The dual-control method allows for both tightly-controlled standard processing and easily customized special-case processing.

Like the GLA\_ANC\_06 and GLA\_ANC\_07 datafiles, the Control File will be based on the ‘KEYWORD=VALUE’ construct. The construct consists of a line containing a keyword/value pair delimited by an equals sign (=). The ordering of the keywords is not relevant but should follow a convention for consistency. Multiple instances of certain keywords are allowed. Comments may be placed in the control file by prepending the comment with a # character. Lines should be limited to a maximum of 80 characters.

Required single-instance keywords include:

TEMPLATE_NAME=	Name of the control file template.
EXEC_KEY=	Unique (per day) execution key
DATE_GENERATED=	Date the control file was generated.
OPERATOR=	Operator who generated the control file.
CYCLE=	Cycle of data
REV=	Revolution of data

Required multiple-instance keywords include:

INPUT_FILE=	Input file and version.
OUTPUT_FILE=	Output file and version

Optional multiple-instance keywords include:

SURFACE_TYPE=	Surface Type to Process (for all ATBDs)
L1A_PROCESS=	L1A Process to Execute
WAVEFORM_PROCESS=	Waveform Process to Execute (or scenario)
ATMOSPHERE_PROCESS=	Atmosphere Process to Execute (or scenario)
ELEVATION_PROCESS=	Elevation Process to Execute (or scenario)

Filenames and versions included in the Control File are generated by the scheduler via a pre-defined recipe. File naming is currently TBD, but a requirement for naming is that output names may be uniquely generated from input names.

Additionally, pre-defined, subsystem-specific identifiers may specify which processes are executed, rather than a verbose list of processes. The SURFACE\_TYPE keyword specifies over what type of surface processing should occur. The default is all surfaces. Keywords and values are not case-specific (they will be converted to all lower case during parsing) but it is recommended that, for consistency, keywords be entered in upper case.

### 22.1 Control File Tempate

# DRAFT

```
#  
# These are comments which are skipped by the parser  
#  
CONTROL_FILE_NAME= Name  
EXEC_KEY= Key  
DATE_GENERATED= Date  
OPERATOR= Name  
CYCLE= Cycle  
REV= Rev  
INPUT_FILE= Input_File File_Version  
OUTPUT_FILE= Output_File File_Version  
SURFACE_TYPE= Surface Type  
LIA_PROCESS= LIA Process or Scenario  
WAVEFORM_PROCESS= WF Process or Scenario  
ATMOSPHERE_PROCESS= Atm Process or Scenario  
ELEVATION_PROCESS= Elev Process or Scenario
```

## 22.2 END-OF-CONTROL-FILE

Values for fixed-response keywords are listed below:

# DRAFT

Keyword	Values
SURFACE_TYPE	ALL (default)
	LAND
	OCEAN
	SEAICE
	ICESHEET
L1A_PROCESS	ALL
	NONE (default)
	L_Gen_ALT
	L_Gen_ATM
	L_Gen_ATT
	L_Gen_ENG
WAVEFORM_PROCESS	ALL
	NONE (default)
	W_Assess
	W_DetGeoSurTyp
	W_CalcOtherCh
ATMOSPHERE_PROCESS	ALL
	NONE (default)
	A_interp_pod
	A_interp_met
	A_mbscs
	A_cal_cofs
	A_ir_bscs
	A_g_bscs
	A_avg_bscs
	A_cld_lays
	A_pbl_aer_lays
	A_aer_lays
	A_cld_opt_prop
	A_aer_opt_prop
ELEVATION_PROCESS	ALL
	NONE (default)
	E_CalcLoadTD
	E_CalcOceanTD
	E_CalcEarthTD
	E_CalcPoleTD

# DRAFT

	E_GetGeoid
	E_CalcTrop
	E_IntrpPOD
	E_CalcStdIR
	E_CalcLdIR
	E_CalcOcIR
	E_CalcSiIR
	E_CalcIsIR
	E_CalcStdSp

Sample L1A-Only Control File

```
#  
#Sample Control File which only runs L1A Processes  
#  
TEMPLATE_NAME= L1A_AND_PARTIAL_WF_CONTROL_FILE  
EXEC_KEY= 000012  
DATE_GENERATED= 26-January-1999  
OPERATOR= jlee  
CYCLE= 01  
REV= 2000  
SURFACE_TYPE= ALL  
INPUT_FILE= anc04_01_2000_0.dat 2  
INPUT_FILE= anc05_01_2000_0.dat 1  
INPUT_FILE= gla00_01_2000_0.dat 1  
OUTPUT_FILE= anc06_01_2000_0.dat 2  
OUTPUT_FILE= gla01_01_2000_0.dat 2  
OUTPUT_FILE= gla02_01_2000_0.dat 2  
OUTPUT_FILE= gla03_01_2000_0.dat 2  
OUTPUT_FILE= gla04_01_2000_0.dat 2  
L1A_PROCESS= ALL  
WF_PROCESS= W_ASSESS  
WF_PROCESS= W_DETGEOSURTP  
END-OF-CONTROL-FILE  
#  
# End of Control File  
#
```

## 23 Appendix D - Reprocessing Scenarios

All identified scenarios that will be eventually tested

# DRAFT

Scenario	Input	Output	Dependencies	Processes
End to end	Level 0, ANC data, Cntrl	GLA01-15, Metadata		All
End to end Lidar	Level 0, ANC data (POD, Met, Cal file), Cntrl	GLA02, 7-11, Metadata		L1A Atm ATBD, L1B Atm ATBD, L2 Atm ATBD, POD interp, Met interp
End to end Altimeter	Level 0, POD, PAD, Met, Cal file, Cntrl	GLA05,6,12-15, Metadata		L1A Altimeter ATBD, L1B Waveform ATBD, L1B Elevation, L2 Elevation, POD, PAD, Geoloc
Level 1A Altimeter	Level 0, Cal file,Cntrl	GLA01, Metadata		L1A Altimeter ATBD
Level 1B Waveform	GLA01, POD, PAD, Cal file, ANC 19, surf_type_grid, Cntrl	GLA05,Metadata		L1B Waveform ATBD, POD, PAD, Geoloc, surf_type interp
Level 1B Elevation	GLA05, GLA09&11 (if avail), tide coeff, geoid, ANC 12, DEM, Met	GLA06, Metadata		Geoid, Tides, Geoloc, Met, DEM interp, Instr Range Cor (5) Reflectance, Atm Flag
Level 2 Elevation	GLA05, GLA06, 4 Masks	GLA12-15, Metadata		Geoloc, Instr Cor Range Region-Specific Parameter Calculations
Waveform Algorithm changes (standard, ice sheet, sea ice, ocean, land)	GLA01, GLA05, Cal file	GLA05, Metadata	GLA06, GLA12-15 (1 or all)	Specific Waveform algorithm process, Geolocation
Replace POD and/or PAD on GLA05	GLA05, POD and/or POD	GLA05, Metadata		POD and/or PAD, Geolocation
Replace PAD and/or POD on GLA06	GLA06, PAD and/or POD	GLA06, Metadata	GLA12-15	PAD and/or POD, Geolocation
Met changes, redo Met Cor	GLA06, GLA12-15, Met file	GLA06, GLA12-15, Metadata		Met Interpolation, Geolocation
Tides Change, redo tide cor	GLA06, GLA12-15, tide coeff	GLA06, GLA12-15, Metadata		Tide algorithms, Geolocation
Geoid changes	GLA06, GLA12-15, Geoid	GLA06, GLA12-15, Metadata		Geoid
Standard Instr Cor Changes	GLA05, GLA06, GLA12-15	GLA06, GLA12-15, Metadata		Standard Instr Cor Algorithm, Geolocation
Region Spec Instr Cor Changes	GLA05, GLA06, GLA12-15	GLA06, GLA12-15, Metadata		Region Specific Instr Cor Algorithm
Reflectance Algorithm changes	GLA05, GLA06, GLA12-15	GLA06, GLA12-15, Metadata		Reflectance ATBD
Change GLA06 based on WF Algorithm changing for GLA05	GLA05, GLA06, GLA12-15	GLA06, GLA12-15, Metadata		Range Instr Cor Calculation, Geolocation
Replace PAD and/or POD on GLA12-15	GLA12-15, PAD and/or POD	GLA12-15, Metadata		POD and or PAD, Geolocation
Creation of GLA07	GLA02, Met, POD, 400	GLA07, Metadata		Interp POD,Interp Met,

# DRAFT

BackScatter Profiles	sec avg file			Molec BackScat Profiles, Calib Coeff, 1064 BackScat Profiles, 532 BackScat Profiles
Creation of GLA08 Aerosol Layers	GLA07, Constants, GLA09	GLA08		1 and 4 sec BackScat averages, PBL/Aerosol <20 km layers, 20-40 km aerosol layers
Creation of GLA09 Cloud Layers	GLA07, Constants	GLA09		1 and 4 sec BackScat averages, Cloud Layers
Creation of GLA10 Cross Section Profiles and Creation of GLA11 Optical Depths	GLA07, GLA08, GLA09, Constants	GLA10, GLA11		Cloud Optical Properties, Aerosol Optical Properties, 1 and 4 sec BackScat averages

## 24 Appendix E - Software Libraries

A number of utility programs will provide a means of manipulating the product files to provide data for analysis and/or visualization. These utilities will be located in a predefined libraries. These libraries will be categorized as:

- Data Management
- Math
- OS Dependent
- HDF Toolkit
- Utilities (Program and system)

The System utilities will perform the following functions:

1. Verify ANC files
2. Extract file Information
3. Dump a file of data (e.g. Hexadecimal dump)
4. Debug
5. Verify HDF data
6. Browse Metadata(view/creation)
7. Update coefficients
8. Formatter (convert SCF to HDF)
9. Unformatter
10. Trend Analysis
11. Quality Assessment
12. Sort/Merge
13. Plot (IDL)
14. Diagramatic status report on products
15. Noesys analysis of data
16. Post processing QA (Create and image)
17. Input file QA (metadata)
18. QA corrections

# DRAFT

There will be other utilities, callable by a program, that will exist in appropriate libraries and will perform the following functions:

1. Read/Write
2. Interpolation
3. Statistics
4. FFT
5. Curve Fit
6. Matrix math
7. Special functions
8. String handling
9. Error handling
10. program and physical Constants
11. System time
12. Data conversion
13. GUI
14. Tape handling
15. Time and date
16. HDF toolkit
17. Message generation
18. Variable type ID
19. Meta data creation
20. Browse creation
21. Derived types

## 25 Appendix F-Glossary

<u>Module</u>	A collection of program statements with four basic attributes: input and output, function, mechanics and internal data
<u>PDL</u>	Program Design Language (Pseudocode). A language tool used for module programming and specification. It is at a higher level than any existing compilable language.
<u>Process</u>	An activity on a dataflow diagram that transforms input data flow(s) into output data flow(s)
<u>Program</u>	The smallest set of computer instructions that can be executed as a stand-alone unit
<u>Model</u>	A graphical representation of a system
<u>Scenario</u>	A single execution path for a process
<u>State Transition Diagram</u>	Graphical representation of one or more scenarios.
<u>Structured Design</u>	The development of a blueprint of a computer system solution to a problem, having the same components and interrelationships among the components as the original problem has.
<u>Structure Chart</u>	A graphical tool for depicting the partitioning of a system into modules, the hierarchy and organization of those modules, and the communication interfaces between the modules.
<u>Stub</u>	(alias dummy module) a primitive implementation of a subordinate module, which is normally used in the top-down testing of superordinate (higher) modules.
<u>Subroutine</u>	A program that is called by another program